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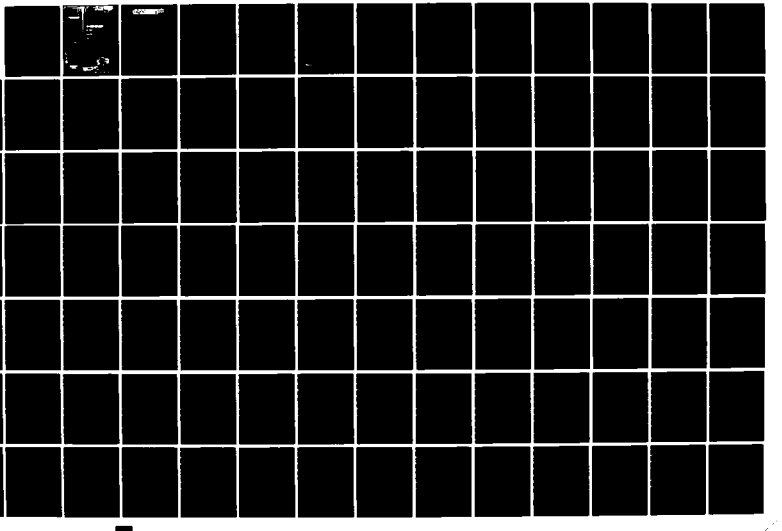

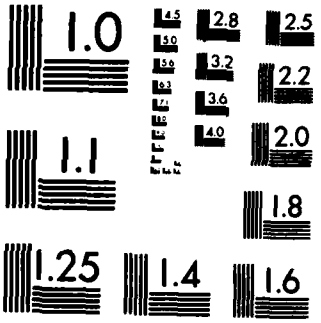
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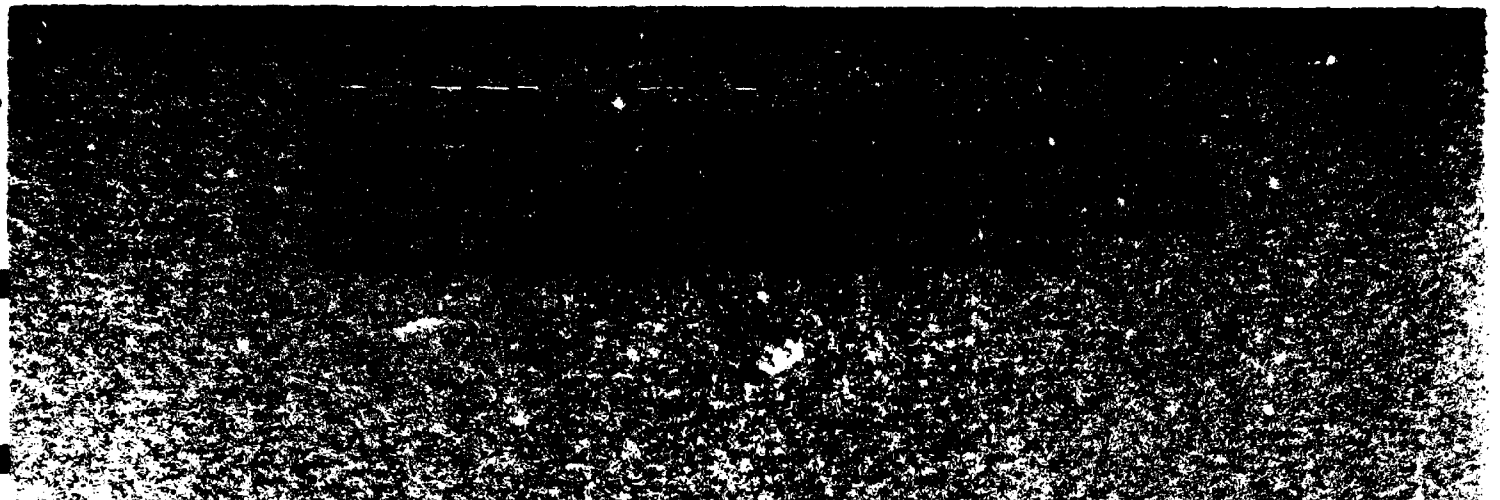

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This Note examines decisionmaking in Soviet industry through a case study of three branches of Soviet machinery production: data processing equipment, agricultural machinebuilding, and chemical-petrochemical equipment construction. It explores various facets of a decisionmaking system characterized by low-level conflict without clearly defined or predictable forms of conflict resolution. The study aims to cast a new light on relations between clients and suppliers in Soviet industry, and on the environment in which decisions on the importation of foreign technology are made in the hope of better predicting Soviet economic behavior.

A RAND NOTE

THE ADVERSARY SYSTEM IN LOW-LEVEL SOVIET ECONOMIC DECISIONMAKING

David Apgar

August 1984

N-2111-AF

Prepared for

The United States Air Force

Rand
1700 MAIN STREET
P.O. BOX 2138
SANTA MONICA, CA 90406-2138

PREFACE

The Note was written as part of a project on "Economic Decisionmaking and Soviet Power in the 1980s," under the sponsorship of Project AIR FORCE and in association with the Office of the Assistant Chief of Staff, Intelligence, Hq USAF. The project hopes to enhance understanding of the possible directions of Soviet economic policy choice by studying the interaction between central economic policy formation and decisionmaking on the one hand, and major sectoral resource allocation problems on the other.

The Note examines decisionmaking in Soviet industry through a case study of three branches of Soviet machinery production--data processing equipment, agricultural machinebuilding, and chemical-petrochemical equipment construction. It explores various facets of a decisionmaking system characterized by low-level conflict without clearly defined or predictable forms of conflict resolution. It is hoped that such an approach will cast a new light on relations between clients and suppliers in Soviet industry, and on the environment in which decisions on the importation of foreign technology are made. Therefore, the Note should interest elements of the U.S. national security community concerned with the assessment of Soviet economic potential and with its implications for more general threat analysis.

The study was prepared as a dissertation in partial fulfillment of the requirements of the doctoral degree in policy analysis at The Rand Graduate Institute. The faculty committee that supervised and approved the dissertation consisted of Charles Phelps (Chairman), Abraham S. Becker, and Robert Solow (Massachusetts Institute of Technology).

SUMMARY

The effectiveness of central or top-level economic decisionmaking in the USSR depends in part on the **quality of the information about interactions** among lower-level elements of the economic system. In many cases in the nondefense industrial economy, this information comes from **the feedback industrial users or clients return to their suppliers and the suppliers' responsiveness to that feedback.** It is argued that **this network of interactions constitutes an adversary system** that both generates and mediates disputes between clients and suppliers at the ministerial and plant levels. The system displays two striking features: **Transacting enterprises settle into predictable, antagonistic roles of client and supplier, and there is an apparent lack of any set procedure for deciding the resulting disputes.** This Note attempts to outline such a model of Soviet low-level economic decisionmaking through case studies of three Soviet machinery sectors--mainframe data processors, agricultural machinery, and chemical/petrochemical equipment.

Most studies of Soviet industrial behavior assume that supplier capabilities and intent drive production. The assumption of this study is that initial conditions describing the client are often as important. **Five client characteristics are viewed as determining the quality and content of the client's feedback: availability of component substitutes, pressure from the center on the client to perform, client sensitivity to the performance of components, the rate of technological change affecting components, and the share of the component in the client's costs.** These characteristics can serve as the basis for predictions of the distribution of time, energy, and concern that an enterprise will allocate to the various material inputs into production. Considered jointly, the characteristics provide a loose definition of client competence in evaluating the supply of components and sending meaningful signals back to a supplier to correct problems. The better informed this evaluation, the more useful will this information be for central economic decisionmaking.

The three case studies try to link differences in industrial outcomes to variance across the sectors in the characteristics of client feedback. **In the computer sector, user feedback to computer suppliers is poor owing to availability of substitutes, low priority of the users, client insensitivity to computer performance and the rapidity of technological change.** This prevents effective supplier response and renders useless the information on computer utilization generated by the adversary system. **With regard to agricultural tractors, the problem is irresponsible client feedback.** The chief reason for this is that the client bears no financial responsibility for the differences in price among the tractors that are bought for him by the machinery purchasing agency. In sharp contrast, **the client for chemical/petrochemical equipment tends to be risk-averse, because of strong pressure from the center and dependence on precise functioning of key components that have no good substitutes.** Because of feedback from a highly risk-averse client, the **supplying ministry seems to have evolved in considerable part into a maintenance and service organization for foreign components** and to have partly atrophied in its function as an original equipment manufacturer.

Assuming that we understand top-level Soviet economic policy, the price and cost structure of the industries in question, and the conditions governing foreign trade in their products, the considerations of this Note would permit refinement of predictions of Soviet economic decisionmaking in nondefense sectors, to include the projection of Soviet demand for foreign technology. That demand is partly the product of information arising from bilateral negotiations among various supplier and buyer organizations, and not just the result of the activities of a central planning agency such as Gosplan or of a Central Committee department. But the negotiations go on in an environment of uncertainty, lacking fixed arbitral procedures. The upshot is that feedback reaches Soviet suppliers by very strange channels. Feedback there is; but we must understand the structure of clients as well as suppliers to comprehend it and to exploit it in predicting Soviet economic behavior.

ACKNOWLEDGMENTS

The author expresses his gratitude to his former Rand teachers Abraham Becker, Nancy Nimitz, and Charles Phelps for careful criticism and helpful comments on earlier drafts of this study. Thanks are also due to Joseph Berliner (Brandeis) and Robert Solow (MIT) for their sympathetic reading and detailed comments, which improved the manuscript greatly. The author is responsible for any imperfections that may remain.

GLOSSARY

aktiv: The group of most active members, the core group

ASU: Automated system of management

ASUTP: Automated system of management for technological processes

Gosbank: State Bank

Gosplan: State Planning Committee

Gossnab: State Committee for Material-Technical Supply

Gostechnika/GKNT: State Committee for Science and Technology

kolkhoz: Collective farm

Mingazprom: Ministry of Gas Industry

Minkhimneftemash: Ministry of Chemical and Petrochemical Machinebuilding

Minkhimprom: Ministry of Chemical Industry

Minneftekhimprom: Ministry of Petroleum Refining and Petrochemical Industry

Minnefteprom: Ministry of the Petroleum Industry

Minpribor: USSR Ministry of Instrument Building, Automation Equipment and Control Systems

Minradio: USSR Ministry of Radio Industry

Mintraktor: Ministry of Tractor and Agricultural Machinebuilding

Minzhivmash: Ministry of Machinebuilding for Animal Husbandry and Fodder Production

raykom: rayon Party committee

Sel'khoztekhnika: State Committee for Supply of Production Equipment to Agriculture

sovkhoz: State farm

TsSU: Central Statistical Administration

Note: A number of Soviet ministries and state committees have both central and republican components. The central component is usually indicated by the designation "USSR" (Ministry of...)

CONTENTS

FIGURE

I. INTRODUCTION

To predict the behavior of an economic system, we must know how it makes economic decisions and how it attempts to implement its choices. Decisionmaking is complex, however: We cannot learn the decision procedures of an organization or system as easily as we can learn its budgeting. In particular, the various levels of industry are often responsible for different categories of industrial decisions. This Note attempts to characterize a little-explored level of Soviet industrial decisionmaking and to draw several conclusions concerning possible directions of the Soviet economy from the patterns that emerge.

Central or top-level economic decisionmaking in the USSR is only as good as the information about industrial interactions on which it is based. In many cases, this information comes from the feedback industrial users or clients return to their suppliers and the suppliers' responsiveness to that feedback. This study examines the adversary system that generates but also mediates disputes between clients and suppliers at the ministerial and plant level in Soviet industry. We may think of the adversary system as a decisionmaking process itself whose by-product is information on strains in industrial sectors. The operation of such an adversary system in the Soviet context implies that client characteristics will affect economic decisionmaking at the center. This Note does not examine top level decisionmaking; it is concerned with the interactions among plants and between plants and ministries.

THE SOVIET ADVERSARY SYSTEM

This study argues that information on the efficiency of the non-defense industrial sector available to central agencies for top-level economic decisionmaking comes partly from an adversary system that mediates the needs of industrial clients and the capabilities of industrial suppliers. The operation of the system depends on the responsiveness of suppliers to client needs and on the feedback from clients to supplier responses. It is therefore necessary to define the

adversary system, the information on industrial sector functioning that it produces, and the conditions determining client feedback on which it partly depends. After doing so, the operation of the adversary system is illustrated in a hypothetical economic decision such as the determination of technology import levels.

Adversary Decisionmaking

The cases discussed in Secs. II-IV show a strong pattern of conflict at low levels of industry combining two striking features: a system in which transacting enterprises settle into predictable, often antagonistic roles of client and supplier, and the apparent lack of any set procedure for deciding the resulting disputes. Several Western scholars have drawn attention to the role of local rayon or oblast committees of the Communist Party in the adjudication of these quarrels, and the case material here also supplies some examples of such activity. The result is that the regional articulation of the Party system begins to resemble the American judiciary, and Soviet managers discover increasing demands made of their litigious capabilities.

Although this study stresses lateral adversary relations between transacting enterprises, we also see vertical adversary relations between enterprises and ministry administrations or between ministry administrations and the central decisionmaking apparatus. Section IV touches on such vertical relations and provides some indirect evidence for their existence.

Soviet low-level decisionmaking, in this view, differs from textbook descriptions of bureaucratic decisionmaking as well as from the decisionmaking of classical markets. For the purpose of discussion, it helps to break down decisionmaking systems along two dimensions. The first dimension captures the ability of a system to express diverse objectives, and the second captures the ability of a system to generate consistent strategies. The system that expresses only a monolithic objective (as an approximation to the diverse objectives held by the members or parts of the system) and yet fails to generate a strategy to accomplish it is embryonic and of little interest here. The system that articulates only a single uncontested objective and routinely generates a strategy to accomplish it, approaches the ideal bureaucracies

discussed variously by Weber, Allison, Simon, and many other organization theorists. The system that can generate a clear, consistent strategy in the face of competing, complex objectives will come closer to maximizing global system welfare, as do classical markets and such mature interest-group coalitions as the U.S. Congress. This leaves the system that can generate complex, competing objectives but fails to generate consistent strategies to accomplish any part of them, a niche that seems to contain Soviet industrial decisionmaking at the ministerial and enterprise (or factory) level. The Soviet system is more evolved than an ideal bureaucracy because it can express competing industrial interests, but it lacks the fixed arbitral procedures that make such bureaucracies as General Electric particularly effective in static industrial environments. The lack of fixed arbitral procedures differentiates the Soviet system from classical markets as well: Prices dictate outcomes in a market despite the presence and expression of competing industrial claims, but what systematic form of conflict resolution can the Soviet manager expect? The following table formalizes this pair of distinctions.

Types of Decisionmaking Systems

	fixed decision procedures?	
	No	Yes
Single interest	Embryonic system	"Rational man" bureaucracy
Competing interests	Soviet nondefense industry "Adhocracy"	Interest group coalitions (e.g., Congress) Classical markets

Information for the Central Agencies

Central agencies such as Gosplan (the State Planning Committee), the Presidium of the Council of Ministers, and the departments of the Communist Party's Central Committee seem to assume responsibility for most general decisionmaking in the Soviet nondefense economy. The decisions they take depend partly on resource constraints such as the scarcity of hard currency and on sector priorities and general economic objectives set by the Party leadership in the Central Committee and Politburo. However, top-level economic decisionmaking is also dependent on information about the functioning of particular sectors, especially the capital goods and industrial sectors. Only with information on strains in each industrial sector can the central decisionmaking apparatus resolve questions on such matters as import policy in accordance with the priorities and constraints it faces. The adversary system helps furnish such information.

This Note sketches a relationship between several observable characteristics of particular Soviet industrial sectors and the quality and content of information available to central decisionmakers on the strains plaguing those sectors. An understanding of the way Soviet industry generates information about itself would enable us to model top-level economic decisionmaking as a rational (comprehensible) process deploying constrained resources to meet fixed objectives under certain cognitive limitations. Such a model would be an improvement over depictions of Soviet economic decisionmaking as a rational process under no information constraints, and as a rational process under insurmountable information constraints.

The working of an adversary system should affect both the content and quality of information available to the center. The more concerned a client is about supply of a particular component or capital good, the more abundant and informative should be his feedback in industrial interactions. An understanding of the adversary system might be doubly potent: It could predict both the direction in which adversary interaction pushes the center and whether that direction should improve or degrade overall industrial performance. The material that follows is not so ambitious. On the basis of limited evidence, this study can hope only to throw out interesting leads.

Ideally, one would gauge the quality of information produced by the adversary system by measuring its completeness and accuracy as a description of various sectors' efficiency. Among other things, this requires an unobtainable knowledge of all ordinal utilities and production functions in the Soviet economy. Backing off a bit from the ideal, one can still hope to distinguish the squeaky wheels that are about to fall off from those that will last forever, and to distinguish the golden silences from the deceptive ones. The modest goal here is to give a broad-brush picture of which adversary relations are likely to produce information useful to a top-level decisionmaker.

Characterizing the Client

The value of the present approach to Soviet industrial decisionmaking depends on its ability to harness observable characteristics of particular industrial sectors and to draw conclusions about the usefulness of information arising from adversary relations in those sectors. From those we may make further inferences about top-level decisionmaking in the economy. We may think of these observable characteristics as a set of initial conditions. The model of an adversary system lacking fixed arbitral procedures supplies the dynamic that leads these conditions to some industrial outcome. Here it is assumed that the initial conditions describing the client are often as important as those describing the supplier in determining industrial outcomes in the Soviet Union. Most commentators assume that a Soviet supplier's capabilities and intent drive production, so the burden here is to demonstrate the fruitfulness of a complementary assumption relating clients to outcomes.

The purpose of this Note is not to characterize Soviet industrial clients in general economic terms, however, but to characterize the feedback they are likely to return to a supplier. Client feedback and supplier responsiveness determine the ability of the adversary system to produce information that can eventually resolve industrial problems. The better the client feedback and the supplier responsiveness, the better the information. Five characteristics seem to go a long way in determining the quality and content of feedback from a given industrial

client. Variance in these characteristics across clients in different sectors should explain variance in adversary system outcomes (especially information quality), if we control for supplier responsiveness. Alternatively, adversary system outcomes in a given sector should be predictable from a description of the client in terms of these five characteristics together with a similar analysis of the supplier.

The five characteristics listed below attempt to predict the distribution of time, energy, and concern that an enterprise will allocate to the various supply components or materials competing for the attention of managers charged with procurement:

- Availability of component substitutes
- Pressure from center on client to perform
- Client sensitivity to component performance
- Rate of technological change affecting component
- Cost share of component

Availability of substitutes: A Western economist might wish to distinguish between technological and economic availability. The former directs attention to the technical production function: Components performing unique functions permit management no recourse in the event of supply shortfall. The supply of unique components therefore commands greatest management attention (all other things being equal). Economic availability is concerned with the cost of substitutes: The supply of components whose substitutes are costliest (such as those displaced by labor) require special management attention. In the Soviet Union, technological availability is of prime importance.

Pressure from the center: The greater the pressure from the central agencies on a client to perform, the more intensely will management monitor supply of all parts and material.

Sensitivity to component performance: The supply of components critical to the successful operation of a client's product will draw closest management scrutiny. The possibility of performance shortfall attracts management attention.

Rate of technological change: The more rapidly a component technology changes, the more difficult will be the task of evaluating and criticizing component suppliers.

Cost share of component: Where projects are entirely or largely self-financed, including investment, the cost share of a component will also influence the attention management pays to supply.

Taken together, the characteristics provide a loose definition of client competence in evaluating component supply and sending potent signals back to a supplier through the adversary system. A signal is potent to the extent it provides sufficient information to correct a problem. The better informed the evaluation, the more potent the feedback; and the more potent the feedback, the more useful the information produced through the operation of an industrial adversary system for the purposes of central economic decisionmaking.

A Context for the Adversary System

What can the adversary model ultimately explain? Consider a hypothetical outcome in Soviet-Western trade: the purchase of 100 snow-blowers from Liechtenstein. Let us now trace the outcome back through the operation of three decision systems--the international market, the Soviet central decisionmaking apparatus, and the adversary system characterizing supplier-client relations at low levels of Soviet industry--noting which parts of the explanation are or are not dealt with in this Note.

The international market mediates world snow-blower supply and Soviet demand (comprising an import decision by Gosplan and a hard currency offer from an import agency) to yield a trade outcome: the import into the Soviet Union of 100 Liechtenstein snow-blowers. This Note does not consider the determinants of world capital goods supply, nor the operation of the Soviet central decisionmaking apparatus, of which the import decision is the direct product.

The Soviet central decisionmaking apparatus mediates snow-blower priority and hard currency constraints on the one hand, and information on strains in the Soviet snow-blower sector on the other, to yield an import decision. This Note does not consider the effect of priorities

and general economic objectives or resource constraints on economic decisions from the center: The logic is laid out in every text on the Soviet economy. Information on industrial strains, however, is partly a product of the operation of the adversary system considered here.

The adversary system mediates the responsiveness of the Soviet snow-blower ministry (Minsnoblo) to client needs, and the feedback from the Moscow City Street-cleaning Agency to Minsnoblo, to yield information, let us say, on an expected, unavoidable shortfall of 100 snow-blowers. This is the upshot of an industrial dispute concerning the feasibility of the Agency's technical specifications submitted to Minsnoblo last April, heard by three Moscow City Party officials at different levels in the city's Party hierarchy. This Note does not explicitly address determinants of supplier responsiveness, but it does attempt to characterize the quality of client feedback in terms of the care and resources the client is likely to bring to the procurement of the needed capital goods.

We may imagine that snow-blowers have no known machinery substitutes; that labor (contrary to fact, perhaps) does not replace snow-blowers very cheaply; that the Kremlin is adamant about having clear streets in Moscow this winter; that snow-blower effectiveness is critical to the Agency's performance in winter; and that snow-blower technology is not outrunning the grasp of Agency engineers. The implication is that client feedback should be of high quality, and that a dispute with a nonperforming domestic supplier should provide sufficient information on the relative utility of snow-blowers for street-cleaning to permit higher authorities to resolve the Agency's dilemma effectively.

Figure 1 sets the logic in the context of such an import decision. Circles identify the function of decisionmaking systems; boxes identify input variables that the systems mediate and output variables that they determine. The dashed linkages highlight the relations treated in the following sections. The flowchart does not represent bureaucratic entities and information flows between those entities, but rather variables and the functions of linked decision systems.

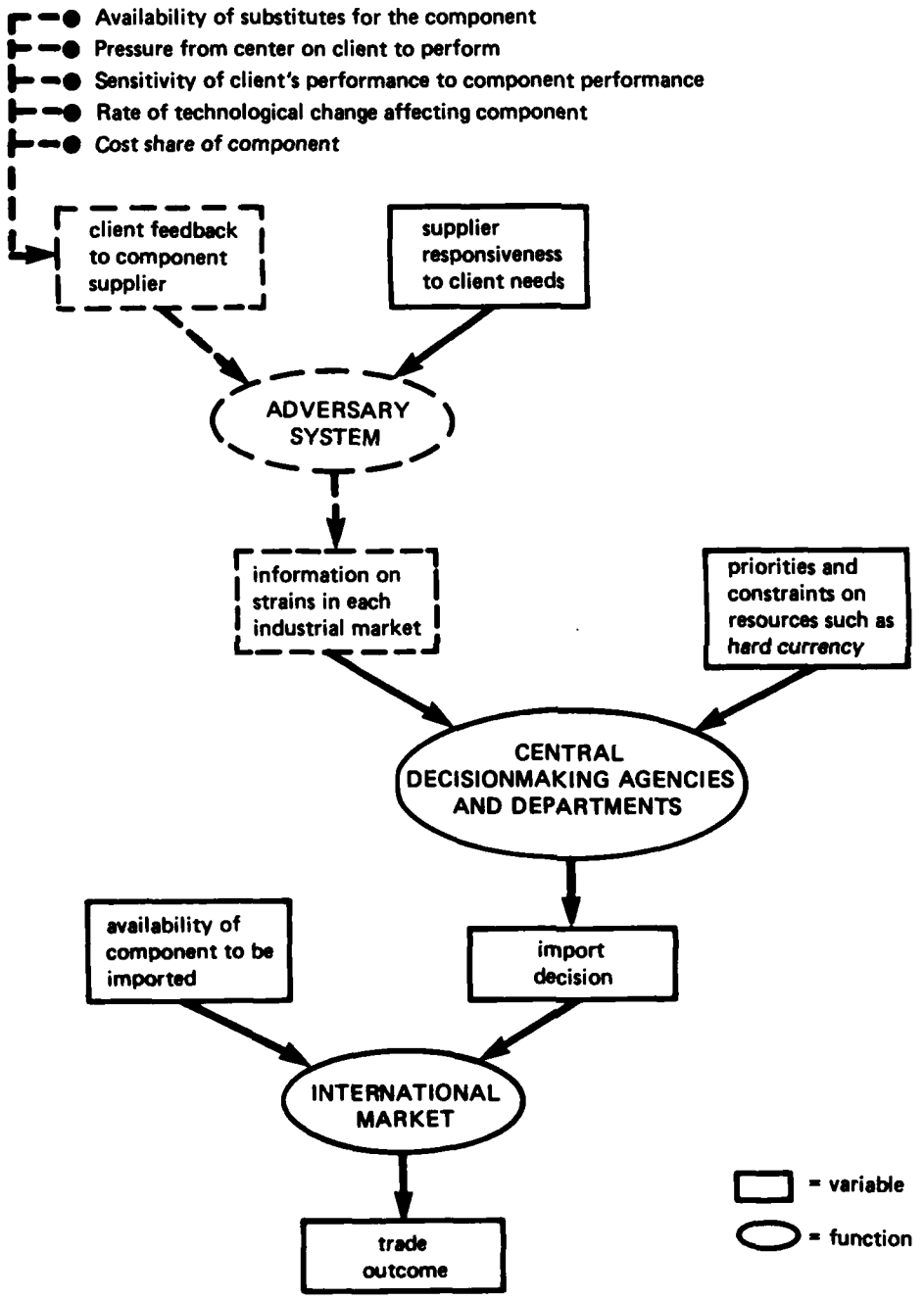

Fig. 1 — Flowchart of adversary decisionmaking system

THE CASES

The cases to follow examine adversary relations at the ministerial and plant level in three machinebuilding sectors: mainframe data processors, agricultural machinery, and chemical/petrochemical equipment. All three sectors produce information capable of prompting decisions from the center to import technology. (Headlines on exports of computers and gas pipeline compressor-turbine blades to the Soviet Union, and the 1983 Agribusiness USA exhibition in Moscow, underscore Soviet interest in importing technology in these areas.) The actual outcomes of the adversary system in each sector differ considerably, however. The case studies try to link these differences to variance across the sectors in the characteristics of client feedback discussed earlier.

Ideally, once again, the three cases would control perfectly for supplier responsiveness in order to demonstrate a dependence of adversary system outcomes on client feedback. The three cases do not offer such a control. But the three suppliers do resemble one another to a greater degree than do the client groups, giving us directional evidence for the dependence of adversary system outcomes, and ultimately of central economic decisionmaking in the Soviet Union, on client feedback to suppliers.

In the section on computer construction, the decisionmaking model explains why the buyer's technical incompetence in applications engineering continues to bedevil the sector, in spite of incentive reforms. (It is not necessary that client technical incompetence should cause problems: IBM operates in an environment of technically uninformed buyers.) The decisionmaking model explains in the following section why the creation of a central purchasing agency to procure tractors for farmers has not ironed out the perplexing shortfalls in Soviet agricultural machinebuilding. The section on petrochemical and chemical equipment construction exploits the decisionmaking model to explain how buyer-supplier collusion has created a heavy reliance on foreign technology and an adversary relation between the petrochemical equipment sector and the state.

The computer sector serves clients involved in major manufacturing projects whose costs of inventory and manufacturing control are often a tiny percentage of overall production expense. Ten fingers and an abacus are a substitute for these computing machines (often a good one). The client sectors considered here are usually not the highest priority sectors. The clients are fairly insensitive to computer performance, and the rate of technological change makes it difficult for a client to devise appropriate computer applications. The upshot is a client with little motivation and ability to become technically competent in computer application and maintenance. The first case ascribes to these conditions the apparent lack of direction of Minpribor, the supplying ministry. Many computer specialists feel that Soviet computer importing policy exhibits such indirection, overall.

Tractor construction provides an example of clients with no financial responsibility for the differences in price between the tractors that their purchasing agency, Sel'khoztekhnika, buys for them: so the cost share of equipment upgrades is zero. Because size of the tractor fleet and increased horsepower complement reliability, tractor manufacturers tend to ignore reliability altogether in favor of more and bigger machines. Pressure on the agricultural sector is diffused over several bureaucratic actors. And it is hard to link agricultural output to tractor performance given the vagaries of climate. The upshot is that clients are irresponsible in the feedback they provide to tractor manufacturers; they misdirect Mintraktor in calling for bigger, not more reliable, machines. The second case ascribes the misdirection of the supplier to the structural irresponsibility inherent in tractor buyers' feedback.

Chemical equipment serves clients under strong pressure from the center to perform. Their performance often depends on the precise functioning of such components as steam turbine blades. The technology is well understood. But there are no substitutes for advanced turbine technology in devising an efficient pumping station. The upshot is a risk-averse client prepared to go to great lengths to insure reliability of supply of certain components. The supplying ministry seems to have evolved in considerable part into a maintenance and service organization

for foreign components. The third case ascribes the partial atrophy of the supplier's functioning as an original equipment manufacturer to the feedback of a highly risk-averse client.

In summary, the adversary model provides a logic for the derivation of economic outcomes of an informational nature from combinations of the five main client characteristics described earlier. We observe supplier indirection as a function of client technical incompetence; supplier misdirection as a function of client irresponsibility; and suppler evolution away from production toward general contracting, assembly, and maintenance as a function of client risk-aversion.

LIMITATIONS AND BENEFITS

Apart from the restricted scope of this study of Soviet decisionmaking, bias of the information sources and the limitations inherent in a choice of only three cases for study may also appear to detract from the value of the work. This Note attempts to exploit a source of easily available information, industrial journals tracking ministry and enterprise relations. An information base built on Soviet-reported industrial interactions incorporates considerable bias. The editors of industrial journals in the USSR undoubtedly have agendas that determine which reports of industrial problems they publish and which they neglect. We can therefore not determine from the reports what the full range of industrial strains in the USSR might be. The selection of computers, tractors, and petrochemical and chemical machinery for case study attempts to minimize the bias simply because the Soviets should have little to hide in these industrial sectors. The Western literature on the Soviet defense sector suggests there may be important differences between civil and military industry in matters of supply stringencies, efficiency and cost considerations, and managerial behavior. Therefore, any conclusion drawn from this study cannot be automatically applied to military industry.

The cases permit inference from client feedback characteristics to adversary system outcomes only to the extent that there are more outcomes than explanatory client characteristics, that they control for supplier characteristics, and that they include a broad range of explanatory client traits. This study does not measure up to the first

two criteria, but the criteria are perhaps too harsh for a study supporting its contentions with illustrative, directional evidence. Even so, the five main explanatory client characteristics tend to move in the same direction, pointing to good or poor client feedback, and begin to count as a single independent variable. The study controls for supplier characteristics as well as possible in the choice of documented sectors. And the examples of technically incompetent, irresponsible, and risk-averse clients do cover a fairly broad spectrum of the six characteristics driving client feedback.

There are other, secondary benefits to the present approach to the study of Soviet decisionmaking. The adversary system's mediation of client feedback and effect on the cognitive limitations of the central decisionmakers provides an intriguing nonmarket correlate to Alfred Marshall's First Law; the theory provides a new explanation of the inefficacy of reform in some Soviet industrial sectors; and it suggests a rationale for the argument that overinvestment is as likely as underinvestment in foreign technology (relative to an efficient equilibrium) for some sectors of the Soviet economy.

The adversary model might help relate Soviet central agency demand for technology imports to characteristics of the Soviet clients of machinebuilding sectors. Such a relation would hardly be a surprise in a classical market. In a smoothly functioning market, we could use Marshall's laws to predict that the absolute price elasticity of demand for an input varies directly with the absolute price elasticity of demand for the final product, with the cost share of the factor, with the elasticity of substitution with other factors, and with the price elasticity of supply of other factors. There is an interpretation of these laws in the Soviet case. We could try to relate the volatility of Soviet demand for an American tractor transmission to the volatility of Soviet internal demand for threshers, the cost of a transmission relative to an entire combine, the competitiveness of Soviet-produced transmissions, the volatility of supply of Soviet engines, trailers, suspensions, etc. This interpretation suggests in particular that we examine the nature of the Soviet client receiving the new technology (as well as analyze the factor cost functions and the availability of substitutes) to determine the nature of demand for it.

But the entire chain of reasoning depends, as do Marshall's laws, on the existence of a price structure and profit-maximizing behavior. A sidelight of the present examination of Soviet industrial decisionmaking is the possibility that it will provide grounds for predicting a relation between Soviet demand for foreign technology and Soviet internal demand (on the part of the Soviet client) for the final product. In other words, a model of Soviet decisionmaking may allow us to recapture a correlate to Marshall's First Law (absolute price elasticity of demand for an input varies directly with absolute price elasticity of demand for the final product) in a nonmarket setting.

This study suggests supplier incentive reform will not necessarily improve central economic decisionmaking. If poor client feedback causes the adversary system to throw off misleading information about an industrial sector, the misinformation should persist despite reforms in the supplier ministry. This is apparently the case in the Soviet computer sector.

A further point this perspective on Soviet decisionmaking suggests is that with inadequate client feedback, overinvestment in foreign technology may be as likely a priori as underinvestment. (Paradoxically, if that were the case, Western governments might find their export sanctions inadvertently helping or subsidizing Soviet development. One could hardly expect to impose a cost on Soviet planners by restricting their practice of overinvestment.) The general line of argument on overinvestment in technology from any source is familiar from Nove, who derives it from the artificially low cost of capital to a manager in the Soviet Union.[1] But the present claim rests overinvestment on the structure of industrial decisionmaking itself, since many economic decisions appear to follow from incompetent evaluations of suppliers and clients in conflict. Such a decision procedure has no predisposition against overinvestment, so the symptom might persist even in the face of capital cost reform.

BACKGROUND

The synthesis offered here has a rich ancestry. Joseph Berliner's treatment of the effect of decision rules on Soviet innovation informs the emphasis on industrial decisionmaking in the present work.[2] Berliner's decision rules, however, include rules on profit, sales revenue, labor productivity, innovation, targets, and the so-called ratchet (which refers to the monotonic increase of output targets). The broader sense of decision used here of an accepted protocol for conflict resolution extends Berliner's suggestions but does not figure among them. Berliner also includes a chapter on the effect of Soviet demand on innovation, laying the groundwork for an analysis of the effects of client competence.[3] Nove shows sensitivity to the importance of the marketing or diffusion function in Soviet industry repeatedly in his overview of the Soviet economy.[4] The notion of an adversary system in Soviet industrial development parallels the use of interest groups in analysing coalitions and complex negotiation, as developed by Skilling and Griffiths.[5] The associated idea of the Party as a general-purpose ad hoc industrial arbiter acquired a useful and illuminating metaphor with Hough's suggestion that we think of the modern Communist Party of the Soviet Union as a development in the continental tradition of prefectural administration.[6] We may compare the local Party secretary most usefully, he argues, with the Napoleonic prefect. The advent of an era of industrial conflicts requiring special technical competence for effective adjudication makes this suggestion particularly interesting, for the Soviet prefect has not normally been a technical expert. The notion of the Party as general arbiter goes back farther than Hough, however. Skilling quotes a Czechoslovak commentator: "The Party as the leading and directing political force fulfills its function by resolving intra-class and inter-class interests."[7] Finally, Nove refers briefly to the arbitration tribunals (Gosarbitrazh) whose functions seem to be limited to contract enforcement.[8]

The extent to which failures in the Soviet incentive structure impede technological innovation or otherwise drive decisionmaking that affects demand for new technology is a question to which many commentators have devoted thought and study. This Note de-emphasizes

the subject for this reason, but cannot ignore it altogether. Berliner writes as follows:

> [T]he director of a major scientific research institute earns a salary that is 50 percent larger than that of the highest paid industrial executive in the country....It is not Minerva, however, but Vulcan who works the forge. It is a plausible speculation that the society that honors--and pays--its industrialists more than its scientists may achieve a higher rate of technological advance.[9]

Incentives are important, in Berliner's view, but not independently efficacious in encouraging innovation. To predict innovation, he argues, one must equally consider the environment of suppliers, clients, prices, and decision rules within which a manager operates. David Granick offers a different view: "The essence of the Soviet problem of incorporating new-product development and major new-process development into normal civilian production consists of incentive difficulties."[10] He goes on to explain that adoption of the "American-G.D.R." approach, in which overall subjective evaluations of performance rather than objective, standardized quantitative criteria determine managerial bonus payments, would immediately improve the capacity of Soviet industry to absorb new technology. The following cases suggest, to the contrary, that the existence of a system that encourages adversary relations between suppliers and clients without providing a standard procedure for deciding disputes (such as a price mechanism) would impede technological innovation and diffusion regardless of the prevailing incentive structure. Berliner's assessment seems the safer position to take.

This study of decisionmaking structure complements several useful microeconomic and financial analyses of Soviet industrial development. Berliner, once again, provides several chapters on the evolution of costs and prices of new products in the Soviet Union.[11] He explains the disadvantage to managers of developing new products arising from high startup costs and some of the attempts to reform new-product pricing to enable innovators to take advantage of learning effects. A recent OECD study by Zaleski and Wienert considers the effects on Soviet technology import of counterpurchase and compensation agreements that enable the Soviet Union to get around its hard-currency problems.[12]

This Note attempts to predict variations in Soviet economic decisionmaking given fixed financial arrangements with prospective foreign trading partners.

John Moore offers a provocative essay on agency costs and Soviet planning.[13] His thesis is straightforward: Technological change is simply too expensive in terms of the rise in agency costs it incurs. He defines agency costs as the cost of enforcing a principal's will through the action of uncooperative agents. The thesis is intuitively clear: Soviet planners must sacrifice too much control in unleasing the innovative forces of the country. Moore's peripheral remarks, however, constitute the wealth of his paper. He agrees with Zaleski that the Soviet Union is centrally managed rather than centrally planned.[14] The idea that central authority plays an administrative or even adjudicative role rather than a policymaking role--at least at the lower levels of industry--finds expression in the model of an adversary system lacking standard decision procedures.

At another point, he remarks, "The constant efforts at reform in the Soviet system and the many failures of reform proposals can be understood as a groping for solutions to the problems of agency costs in the face of these measurement difficulties" (difficulties in distinguishing the cost of agency from that of inefficiency).[15] The suggestion is that the inability to distinguish between true inefficiency (where shared objectives are misexecuted) and true agency problems (where objectives in conflict with those of the center are executed) would prevent the achievement of optimal economic outcomes even if planners could successfully overhaul the incentive system. Once again, incentives do not appear to be the sole key to Soviet economic optimality.

Along different lines, toward the end of his essay, Moore points out: "Where all enterprise capital is borrowed, as it effectively is in the Soviet enterprise, the manager faces no loss of personal capital in the event of failure....[M]anagerial decisions would be biased toward risky projects promising high bonus pay-offs."[16] The argument is that without some active discouragement of risky investment in innovation (or foreign technology), the Soviet enterprise manager is likely to be overly risk-prone, much as is the manager of a highly levered

corporation. The discouragement arguably takes the form of success indicators emphasizing current output targets and new-product pricing and incentives that favor long-run production. The implication is that without such impediments to risk-taking, the Soviet manager would tend to overinvest in new technology. It is strange to think that technological overinvestment threatens the Soviet system. The conclusion of this Note explores an alternative rationale for this projection.

II. COMPUTERS

The poor quality of user feedback to computer suppliers prevents effective supplier response and renders useless the information on computer utilization generated by the adversary system. The availability of clerks to substitute for data processors, the insensitivity of client industry performance to computer utilization, and the quick pace of technological change (particularly in input/output technology) explain the secondary place computer employment takes among the concerns of client enterprises. This section concentrates on the ineffectiveness of client-supplier interaction and the lack of any clear message on computer needs arising from the adversary process.

The case material on Soviet development and diffusion of mainframe data processing equipment includes examples of uses and abuses of computers by the domestic clients of the Ministry of Instrument Building, Automation Equipment and Control Systems (Minpribor). These examples support the claim that client technical competence partly determines many low-level industrial outcomes in the sector. However, it is not examples of clients' uses of Minpribor products but rather examples of clients' complaints about Minpribor performance that begin to establish the reason for the importance of client competence. These claims suggest the outlines of the adversary system at work in Soviet industry. The lack of a standard procedure for industrial conflict resolution starts to explain how client competence can affect demand for foreign technology, and why reform of the Soviet incentive structure may prove ineffective by itself.

Kenneth Tasky opens his article on Soviet dependence on Western computer technology with these lines:

> The Soviet computer industry lags behind the West in the number, variety, and technology of computers as well as in auxiliary equipment and supporting services. This has led to a substantial level of imports to meet priority needs.[17]

Several positions on Soviet computer technology are compatible with this

statement. One holds Soviet computer production to be hopelessly inefficient but Soviet central economic decionmaking to be just the reverse. Indeed, the planning apparatus, on this view, is sufficiently sensitive to detect domestic technological lags and sufficiently organized to seek foreign alternatives. Client feedback is unimportant in this scheme; only failings in the structure of incentives prevent the sector from achieving optimal production levels. Every investment from the center has an economic purpose, even if poor enterprise incentives distort the implementation. The pattern of industrial disputes and subsequent resolution illustrated below should call into question each of these points. In particular, we should have less confidence that Soviet decisions to invest in foreign computer technology or in domestic research and development represent sound responses to accurately perceived difficulties in the production cycle.

INDUSTRY STRUCTURE

Soviet commentators include BESM, Ural, and Minsk series machines in the category of second generation machines, and the ES-1050, ES-1040, ES-1030, ES-1022, ES-1010, M-4030, M-7000 and M-400 in the third generation.[18] The ES-1060 appears to represent only evolutionary technological developments. "ES" (or "YeS") refers to the unified series of computers, designated "Ryad," produced in coordination with other Eastern European countries. They are generally designed to perform similarly to IBM mainframe computers and are capable now of speeds of two million operations per second, a figure not unusual for general-purpose research centers in the United States. Input-output problems, software weaknesses, and organizational quirks seriously erode the capabilities of Soviet computer centers, however.

Although the Ministry of the Radio Industry (Minradio) coordinates production of Ryad computers, it is the Ministry of Instrument Building (Minpribor) that occupies center stage in Soviet computer production. The following details are from a trip report by an American team visiting several of Minpribor's facilities.[19]

Since 1967 Minpribor has experimented with economic accountability. It followed the Ministry of the Electrical Equipment Industry in deploying its own funds to finance the entire research-production cycle.

Minpribor is responsible for developing third generation microcomputers, financing the R&D effort out of its own resources. (Most ministries rely on the state budget for capital.) It has organized itself into production associations or mergers of enterprises, formed scientific production associations (mergers of enterprises with R&D institutes), replaced ministerial sub-branch administrations (glavki) with all-union industrial associations, subjected its branches to self-financing, and introduced a new pricing system to encourage new technology. (It is unclear that the state planning agency, Gosplan, has implemented the pricing system completely.) Each Minpribor five-year plan has included a 60 percent change in product mix (which may include considerable goldplating--making cosmetic adjustments in a product to obtain approval for higher sale prices and win bonuses for new product innovation). The ministry has 10,000 product categories, which is large by American corporate standards.

These products bear the mark of highest quality, representing a 4 percent to 5 percent markup over a base price for computing equipment determined by several central agencies, the mark of first quality at base price, or second quality (obsolescent) at a discount. It must be understood that the customer pays a base price for even second-quality goods, but Minpribor receives only the discounted price to discourage extending product life-cycles and to compensate for learning effects in the absence of competitive pricing. Minpribor enjoys a 20 percent profit markup; its margins, in the past, have exceeded that by a factor of two, to the chagrin of the State Committee on Prices. Minpribor's projected image is upbeat: Although most ministries emphasize the fervor with which their workers have striven to meet quotas, Minpribor emphasizes the fervor with which its managers have steered a singular course among the numerous central agencies. It resembles Xerox more than IBM as a managers' organization.

The central agency that appears to supervise computer acquisition, be it foreign or domestic, is the State Committee for Science and Technology (GKNT, or Gostekhnika). It oversees the development of the computer sector in conjunction with Gosplan and the Academy of Sciences and is broadly responsible for coordinating nonmilitary R&D, disseminating scientific information, increasing the efficiency of

research, diffusing new technology, and directing work in several comprehensive interbranch programs. The program direction seems to take the form of documents planning resource allocation across industry, agriculture, construction, transportation, communication, public health and computer equipment construction.[20] Both Gostekhnika and Minpribor at different times enjoyed the leadership of businesslike individuals with a professed interest in industrial efficiency. Unfortunately, there is not enough information available to assess the effect of leadership on a Soviet industrial organization.

Several Central Committee departments--Science and Educational Institutions and Machine Building--may be important players in the industry, but we have little open information on their activities. An example of a minor Party role is a report on the Minsk Electronic Computers Plant, which has charted a course over 20 years from the M-3 (30 operations per second) to the ES-1060 (a reverse-engineered IBM-360 capable of two million operations per second). We may take as typical of one sort of Party-industrial interaction a 1976 award granted to the plant by the deputy chairman of the Presidium of the Supreme Soviet of Belorussia. Both the deputy chairman of the Belorussian Council of Ministers and the "head of a section" of the Central Committee of the Belorussian Communist Party attended the award ceremony.[21] This form of Party-industrial interaction is the most widely publicized, but far from the most important for economic decisionmaking. Indeed, the publicity probably overstates the importance of this sort of award-granting activity in low-level, regional economic activity. The Party's role in adjudicating industrial disputes is more significant: One of the few cases visible in the sources examined for this study appears below.

There are varying views of the future role of computers, depending on the operating or planning bias of the writer. Computers, some hope, will

> draft scientifically substantiated alternatives for plan decisions and ensure selection of the best of them; consider more fully in plans social needs and provide for satisfying them with the most efficient use of labor, physical and financial resources; intensify the complex influence of the plan and economic levers and incentives on accelerating

> scientific and technical progress . . . achieve balances of productive capacity and manpower . . . achieve the combination of sector and territorial principles of planning; raise the effectiveness of external economic ties; make more extensive use of the program-target method in planning; and intensify work on monitoring the course of fulfillment of the plans. [22]

To accomplish this, the Council of Ministers decided in 1966 that Gosplan, the Central Statistical Administration (TsSU), and Minpribor were to approve ministerial plans for management automation (ASU) networks; that Minpribor was to maintain technical standards and compatibility; that Minradio was to build Ryad; that TsSU was to manage Ryad; that the Academy of Sciences was to develop a system of optimal planning; that Gosplan was to oversee the general computer effort; and that Gostekhnika was to pick up miscellaneous other responsibilities.[23] Since then, the Central Statistical Administration has largely dropped out of the effort while the role of Gostekhnika has grown.

CLIENT-SUPPLIER INTERACTION

Computer clients and suppliers spend a fair amount of time blaming one another for industrial shortfalls. These interactions echo in the industrial journals, providing information on the way the adversary system in the Soviet Union resolves or fails to resolve disputes. Here a range of cases illustrates the often difficult emergence of new computer applications from client-supplier interactions.

The evidence indicates that the problems plaguing the computer sector do not arise solely from troubles in the production cycle. Lack of client capability in applications engineering often seem to be the main obstacle to growth of computing power in the Soviet Union. This affirms the importance of buyer initiative and technical competence in the Soviet setting. An ideal command economy might not need buyer competence and initiative: It might be possible to direct a ministry to disseminate computers throughout industry without the support of the ultimate users by mandating it to develop applications and maintain the machines above fixed up-time quotas. Where the economy progresses through the interaction of suppliers and clients in adversary roles,

that is impossible. Buyer initiative and technical competence are unnecessary for successful computer penetration in classical markets, too, when producers find that applications engineering for clients is profitable and undertake the integration of computer systems with customer operations themselves. The deleterious effect of Soviet computer sector clients on computer penetration thus argues for an organizational setting along the lines of the adversary model. The case material also suggests that the attempts to reform the structure of incentives in the Soviet computer sector are not improving outcomes. This is consistent with what we would expect if lack of fixed arbitral procedures disturbed the sector, because such a lack interferes with transactions even when all parties are competitively motivated.

Nevertheless, the computer sector has not stood still. Soviet cybernetic applications now include planning, dosimetry, state statistics, accounting, instruction and higher pedagogy (smart terminals and reference tools), computational linguistics, rural construction, transportation management, oil pipeline transport control, settlement with suppliers, Lithuanian mineral resource requirements, financial calculations for the Azerbaidzhan Gossnab (the state supply agency), personnel administration, analysis of state working capital and current assets, fuel supply, railroad management, and analysis of trade turnover, incomes, distribution costs, and profits of USSR Gossnab organizations. Even if it turned out many of these applications did not challenge the limits of Soviet computer technology, the list is impressive for an economic system whose nondefense sectors typically experience failures in the introduction and diffusion of new technologies.

At least some of the planned uses would challenge any existing level of technology. Plans for a computer network to serve the Russian Soviet Federated Socialist Republic, for example, call for a three-tier system. One tier is devoted to the directive agencies--the RSFSR Supreme Soviet and Council of Ministers. An interindustrial tier will include ASUs for several RSFSR agencies-- Gosplan, Ministry of Finance, Ministry of Construction, the State Committee for Prices, the Central Administration for Materials and Equipment Supply and Marketing, etc. A territorial-industrial tier will unify the ASUs of all Republic

ministries, departments and agencies.[24] Individual ministerial branches will develop the network of the third tier from the bottom up.

K.N. Rudnev, the then Minister of Minpribor, described the establishment of a Minpribor branch management computer center:

> Its primary function is to get information to the Director for the purpose, on the one hand, of revision of volumes of capital-construction contract work for each Gostekhnika contractor, and on the other, of arranging with Gosplan the appropriate ratio of budget payments to branch reinvestment from the store of ministerial profits.[25]

Such a center would link up with every associated branch, department, and agency in the Republic to produce an information transmission and retrieval system substantially different from any computer application in the West.

It is in heavy industry that computers are first penetrating the nondefense economy. (Aeroflot ticketing is another early example.) We immediately find the client's level of technological preparedness linked to success of computerization in the client's industry. By 1978 the chemical industry operated 56 automated systems of management for technological processes (ASUTP) costing two million rubles each.[26] Examples include systems at a polyethylene plant and a nitrogen fertilizer plant supposedly saving a quarter of their value annually.

The experience of the chemical industry is that ASUs are more valuable at the later stages of production, once an enterprise has started to move down its learning curve. The trouble is with the initial computerization of enterprise operations. The Kirovakan Scientific Research Institute "Avtomatika" has built ASUs for technical processes such as copper matte conversion (sulfide processing after smelting) at the Balkash Mining Combine and thermal furnace control at the Usol' Chemical Combine and Buhne Werke. The Yerevan Chemical Combine is receiving packets of applied programs for inclusion in ASU software. The Kirovakan Research Institute nevertheless complains that only three Armenian chemical enterprises are buying ASUs, and one of those had an inactive system for at least two years from lack of personnel. Kirovakan attributes failures in the diffusion of ASU technology in Armenia to lack of coordination among enterprises

attempting to computerize individually.[27] (Software can amount to 50 percent of the cost of ASU implementation.)

Even once an enterprise in the chemical industry sets up a computer system with some applications, its feedback to the supplier can show flaws. The Kiev Institute of Automation has supplied a system for mine processes to the production association "Uralkaliy," which nevertheless failed to determine output quantity and quality and to monitor the main blower and the mine shaft temperature. A team from the client's administration, the Ministry of the Chemical Industry (Minkhimprom), concluded that the ASUTP displayed a low level of scientific and technical development, poor subsystem coordination, and lack of adequate "support" data. The team made a statement *against* peripheral equipment profusion (because of servicing difficulties), yet *for* minicomputers (where servicing problems are bound to be worse because of high repair-cost/total-value ratios).[28] The generality of the client's conclusions and the peculiarity of their recommendations to Minpribor--namely, to step up minicomputer production--cast doubt on their ability to evaluate difficulties in ASU use. However, the Minkhimprom team might have adopted the cynical position that no ASU will ever see the light of repair, so it makes more sense to purchase cheaper processors--disposable computers, as it were.

The chemical industry does not have a very good record of computer utilization compared with other industries, suggesting that the chemical industry is less concerned with computers in its production activities. This in turn implies a low level of concern in the industry with computer acquisition, application, and upkeep, and poor feedback to Minpribor. Minkhimprom computers operated an average of 10.7 hours daily in 1976; the industry-wide average was 11.6 hours. (Other figures reported: Ministry of Railways, 15.5; hydrometeorological service, 15.9; Ministry of Heavy Power and Transport Machine Building, 14.2; Ministry of Chemical and Petrochemical Machine Building (Minkhimneftemash), 10.1; Ministry of Electrical Equipment--10.2, Minpribor itself, 11.4.)

The view of the Central Statistical Administration (TsSU) is that computer centers under so-called *khozraschet*, or economic accountability, as opposed to state budget financing, tend to achieve

higher work loads and greater profitability with their independent budgets. The key appears to be the incentive khozraschet gives a computer center to solicit contracts to provide computer services to organizations lacking their own facilities. If TsSU is right, this is an example of incentive reform (khozraschet) leading to efficient economic decisionmaking on the part of enterprises. Only 12 percent of the computer centers in the Soviet Union were on khozraschet in 1976, however, including those of TsSU, Gossnab, the Ministry of Railways, and the State Bank (Gosbank).[29]

TsSU has trouble with its own branches. The reason appears to be subtler than mere motivational failures. When a maintenance worker wrote to the journal *Sovetskaya Belorussiya* complaining of hundred-ruble computer equipment breaking down for lack of a one-ruble part, an official of the Belorussian Statistical Administration replied that the USSR Central Statistical Administration had put restrictive ceilings on spare part orders from its branches. Refusing to intercede for its branches, TsSU suggested its Belorussian branch request spare parts from the Minsk Experimental Plant for Repair and Technical Maintenance of Computer Equipment of the All-Union Association Soyuzschettekhnika--a request no doubt doomed to oblivion without support from the center.[30] TsSU and Soyuzschettekhnika are at least developing a uniform system of preventive maintenance for computer equipment. But preventive maintenance cannot create spare discs. The question of client competence in this case is complex. Enterprises of TsSU may be well versed in computer technology, but the overall organization of this particular client agency may hamper its effectiveness.

M. Rakovskiy, a deputy chairman of Gosplan in 1977, faults the production ministries. He cites three major problem areas in the production of computers by Minradio and Minpribor: the acute shortage of peripheral equipment, the lack of coordination between ministries, and the tendency to prolong production of the same machines as long as possible with little concern for modernization. He mentions Minradio's three-year delay of the ES-1050 and the ES-1060, the complete failure to meet the ninth five-year plan's target for time-sharing centers, Minpribor's delay of minicomputer production, the Ministry of the Electronics Industry's two-year delay in introducing integrated

circuits, and so on.[31] With regard to the first point, Rakovskiy seems not to be taking into account the repair problems brought up by the chemical industry. Without a good repair network, complex systems with lots of peripherals are worse than simpler systems. His third point brings up the question of goldplating. Of course, it is in the interest of the state's central planning agency to minimize waste of scarce resources on false innovations.

Rakovskiy is not really a third party to disputes between clients and producers in the computer sector, however. As chairman of the CMEA (Council of Mutual Economic Assistance) Intergovernmental Commission on Cooperation of Socialist Countries in the Field of Computer Technology, Rakovskiy blames problems with computer use on

> those who work with the machines--not on the operators, programmers, and debuggers for the most part, but on the managers, the people who organize the work . . . Unimaginative, irresponsible people should be permanently barred from access to equipment costing tens of millions of rubles and from the solution of problems on which the efficient operation of entire branches and the entire economic mechanism depends.[32]

Incompetent client management begins to emerge as a major impediment to technology diffusion.

Client Competence

Two research institutes belonging to Moldavian Gosplan established identical computer centers featuring identical machines (the ES-1033) with complete staffing that subsequently suffered "considerable underloading"--and only an internal partition separated them. Republic Gosplan officials finally succeeded in unifying the centers. In another Moldavian case, the republic's Ministry of Housing and Municipal Services refused to introduce an ASU specifically designed for housing facilities. A similar system, they claimed, was under in-house development. When the republic Communist Party bureau asked the managers of the local (rayon) production administration for housing to visit, two years later, it found the system still under development. "Nevertheless," explained the managers, "there is no need to use someone

else's." The writer of the article, a first secretary of a local Communist Party committee in Kishinev, explains that a bureau session and a "serious talk" with the housing administration managers corrected the problem.[33] This case is both an example of the difficulties posed by uncooperative clients to the computer sector and an illustration of the way the Party may intervene in industrial affairs.

A foreman and an electrician at the Cherepovets Nitrogen Fertilizer Plant offer another example of a computer-sector client abusing its ASU. In this case, the press reported as innovative a management group subsequently accused of practicing the "grossest deception." In December 1973, the plant installed an ASUTP, receiving a bonus and press acclaim. In September 1974, another bonus and further acclaim followed installation of an automated regulation system for natural gas consumption in a process reactor. April 1975 witnessed the installation of an automated system for turbine temperature stabilization and for post-reactor gas regulation. In December 1977, the plant put into operation an automatic regulation system for acid concentration (an automated titrator). By 1978 all systems were 95 percent down. The writers attribute this to low prioritization of mathematical modeling, algorithm development, and computer programming; to understaffing; and to the allotment of only two two-hour preventive maintenance sessions yearly for the plant's M-6000 data processor. The computer operators, as a result, are nearly always unoccupied. The writers also critize the placement of personnel with "worker credentials" in high section positions while many computer engineers elsewhere are seeking better jobs than they have.[34] Although this case certainly illustrates the claim that poorly designed incentives (such as the bonuses for mere computer installation rather than truly innovative use of the technology) can ruin outcomes in an industrial sector, it also strengthens the argument that technological advances have trouble in the USSR without prior client support. This is not a universal truth: Photocopier development proceeded in the United States even though original market research projected saturation at 100 machines.

In 1977, construction used more than 480 ASUs. Severe shortcomings resulted from the predictably inadequate lines of communication between building sites and the computer centers. Plans were made quicker

without the computer.[35] It seems surprising that this client (the several ministries of construction) would invest in computer centers without a decent telecommunications network.

By the end of 1977, Gosplan established a procedure requiring ministries that placed orders for computers to guarantee the equipment would go into operation immediately. Special commissions would make on-site visits to determine compliance with this rule.[36] The measure is draconian if it threatens to stifle client-initiated innovations in computer usage. From this we may conclude that the situation was as bad as suggested by the occasional articles on advanced equipment lying dormant in remote industrial centers for lack of such easily available equipment as transformers.

A case with a certain charm adds to the evidence stacking up against computer sector client management:

> A multiple-user computer center of the Moscow Trust "Soyuzorgsantekhmontazh" was installed in Volgograd. However, no one was concerned beforehand as to where the equipment was to be placed. The Minsk-32 computer was stored for a long time in the warehouse. Later it was placed in the basement of the youth hostel in the immediate vicinity of the elevator shaft and the main pipelines next to the laundry and two shower rooms. The results of such an environment appeared shortly. Hot water inundated part of the machine room and the computer required thorough overhaul. After several months, hot water also entered the cable channels of the computer.[37]

(The irony of the plight of this Minsk-32 comes out when one considers the scarcity of hot water for use by humans in any East European youth hostel.)

The general director of the "Elektronmash" Production Association of Kiev asks what, if not client competence, explains the variance in outcomes in the effort to distribute his computer systems broadly and effectively. The Nizhniy Tagil Metallurgical Complex received a system in December 1975 without calling for adjustments until the beginning of 1977, after the guarantee period had expired; the Rustavi Metallurgists installed a similar system within four months. (An article in the 2 August 1978 *Izvestiya* claims Minpribor never supplied a complete set of equipment to Nizhniy Tagil. The lack of complete sets of equipment

seems to afflict all clients to some extent, however.) From February 1976 to mid-1977, 56 out of 94 Elektronmash computers produced were inoperative because of customers' lack of preparedness, unfinished installation construction, absence of sensors on technological lines (the data input for an ASU), switching problems, secondary-device failure, and lack of qualified personnel. A single institution carries out all personnel training for the Elektronmash M-6000 and M-4030 computers and is clearly unable to fulfill all requests. The production association has even developed a special start-up and adjustment service to hasten computer installation, but the results are discouraging: Average start-up time remained 7.4 months rather than sinking to the projected four months. The Elektronmash director stresses that clients should provide people who at least know why the machine is needed and that prospective computer tasks should be solvable and prepared in advance.[38]

The trouble is that customers often expect Minpribor to take the initiative in solving problems. Thus we read: "The creation of simple and precise instruments for the *remote analysis* of fodder is a completely soluble problem, and the working people in the villages have a *right* to expect that Minpribor will cope successfully with it."[39] Or again: "It is the direct *duty* of Minpribor to take up the production of specialized apparatus for greenhouses. So far, however, orders are placed only after a lengthy process of persuasion."[40] An article from Tashkent cites inadequate air conditioning, insufficient space, and lack of designer-supplied automated management tasks as reasons for underutilization of its ASU.[41] One wonders with the Elektronmash director what a client is expected to provide, if not at least the computer's tasks.

Incentives and Reform

The frustration that clients of the computer industry seem to feel during the absorption of this difficult technology finds expression in the adoption of adversary roles pitting client against supplier. One remarkable article traces the introduction of an ASU at the Minsk Garment Manufacturing Association. The association received the computer because of its steady growth and data flow, having planned nine

tasks for the electronic computer and four for punched-card equipment. Yet the ASU became nothing more than an "automated bookkeeper," losing four tasks from inefficiency and apparently gaining none. The article cites poorly conceived integration with customer operations and the absence of specialists and "technical facilities" as reasons for the poor utilization of the computer. The ASU section of the Minpribor Minsk Production Association "Krupskaya" then designed tasks for the garment association--recording and analyzing product quality, results of intra-factory socialist competition, and labor performance.[42] This stands out as an example of a supplier taking the initiative to perform applications engineering for a client. It is unusual in the Soviet context. The garment association seems to have a fairly good deal out of it. The upshot of the article, however, was to blame the developers (presumably someone other than Krupskaya, who seem only to have designed some software) for discrepancies, errors, and inadequate utilization. In this example of adversary exchange, the designer has suffered.

In fact, the designer does not fare well in many documented industrial disputes between computer producers and their clients. Any Soviet trade journal touching on computers will include articles about designer negligence. In the cases where the client does not appear to have reason on his side, it is worth asking what motive he has to point the finger at a hapless computer designer. One commentator attributes the lack of proper preparatory work at enterprises planning the introduction of an ASU, and the subsequent lack of imagination in using facilities to complete capacity, to the tendency of some directors to "pass the buck" to subordinates.[43] This delegates responsibility for assimilation of a computer to executives who lack the authority to carry it out. The result is that subordinates are unlikely to get cooperation from coworkers in overcoming the design snags inevitable in a new installation. This produces feedback that overstates the inadequacies of the system design.

We must not pin all the blame for client frustration with computer suppliers on the client organization's management, however. Employees often have the greatest reason to resist technological assimilation. One builder's trust abandoned its computer after discovering its employees withheld data for fear that "management can see each day how

little work we do."[44] Any automated system of management (ASU) designed to rely on information that it is not in the informant's interest to provide is simply doomed.

It would be wrong to leave the impression that negative feedback from clients to producers in the computer sector is always unjustified. The attempts of Minpribor to reform itself and of Gosplan to reform the incentives of buyers stem partly from supplier mismanagement, after all. The "Sigma" ASU is unusually friendly in that it hooks up to an enterprise's production operations particularly easily. A state commission endorsed the Sigma project, and many greeted it with enthusiasm. The research institutes and design bureaus that have recently grown to depend financially on assisting bewildered enterprises in incorporating new ASUs, however, have all but blocked the Sigma. More generally, state and ministerial standards for task design have proven too rigid for the needs of individual enterprises.[45] In both cases, the difficult job of the enterprise to implement a novel technology is made intolerable.

The tendency of supplier and client organizations to adopt adversary roles is hardly the simple result of a fractious nature shared by Soviet managers. The pressures on an enterprise director to remain independent of both suppliers and clients is often intense. Ministerial and central agency officials aiming to spread computers throughout industry seem to fail to take the client's organizational environment into account. Akademsnab, the supply administration for academic research, for example, fulfills only one-fourth of the orders the Ukrainian Cybernetics Institute makes on behalf of its experimental plants. When the Institute requisitioned 130 km of installation cable and Akademsnab provided only nine, messengers immediately "galloped off in all directions" to try direct contacts. They eventually found cable in Kiev, Chernovtsy, and L'vov. The use of scrap materials is frequent. The Cybernetics Institute apparently manufactures its own circuit boards. (The author of the article makes the incredible claim that everyone in the Soviet Union involved with circuitry makes his own boards.) The Institute has an automated operation for plate exposure and etching, circuit board assembly technology, and surface soldering capability. Sadly, the Institute could expand production quite easily

to supply all academic institutes.[46] But such cooperation is unlikely.

In 1971 Gosplan and an interdepartmental council on the improvement of national economic management found themselves stalemated in an effort to establish a large-scale integrated computer center in Tula, despite Party support, because of the negative attitude of Tula industrial ministry officials toward the innovation. These officials "stubbornly continued to establish individual computer centers at enterprises and organizations, often without sufficient economic grounds."[47] The reason, of course, was not so much stubbornness as recognition of the importance of industrial independence in what amounts to a system of bilateral adversary relationships whose outcomes are unpredictable.

Another writer asks why one small Volgograd Plant of Tractor Parts and Specifications needed the fancy ES-1030 computer when it could use only about 15 percent to 30 percent of its capacity. The reason given is that the enterprise became *independent* with the acquisition of its computer, able itself to sell machine time, and not reliant on a new set of service providers. A GKNT representative was able to maintain the interest of Volgograd industrialists in a proposal for a municipal computer center precisely until he suggested building the center for the principal prospective user, the Central Statistical Administration. The Soviet writer advocates multiple-user computer centers on logistical grounds (especially repair organization), but despairs of the degree of cooperation necessary to realize them. As a second-best solution, he approves of the secondary redistribution of machine time through the efforts of such enterprises as the Volgograd Plant of Tractor Parts and Specifications. He opines that this redistribution will proceed on a basis "nearer the real needs for machines rather than on the strength of departmental affiliation or a privileged position."[48] The primary message, nevertheless, is that there are strong reasons to guard independence in Soviet enterprises.

Repair is another bone of contention between suppliers and clients in the Soviet computer sector. The Glazovsky regional Sel'khoztekhnika (farm equipment supply organization) acquired an Elektronika-155 electronic-keyboard computer from the Sverdlovsk Experimental Plant "Spetsavtomatika." After two years it broke down. A shop foreman of the Sverdlovsk plant promised repairs within a month. The Glazovsky

director of planning still had not seen the machine after another year.[49] *Ekonomicheskaya gazeta* raised the question whether the Tbilisi plant producing the Iskra-110 computer was obliged to repair it. A Minpribor reply explained that the Georgian plant no longer produced the Iskra-110 and that the client should direct questions to a branch plant of Spetsavtomatika in Biysk, in the Altay![50] The ministries are nevertheless attempting to repair at least third-generation equipment--woe to the owner of a second generation Minsk-32 or a Nairi. The Leningrad division of the Moscow State Experimental Plant for Repair of Computer Equipment serves only TsSU branches, and only for work on imported machines. Spetsavtomatika services domestic machines, as implied above. Minpribor operates both.[51]

CONFLICT RESOLUTION

If Minpribor has been slow in responding to the need for a better articulated repair network, the sector as a whole has at least moved in other ways to aid clients in digesting new technologies. One example is the Leningrad Institute of the Methods and Techniques of Management, which furnishes teams to train management cadres in the use of computers. Higher level administrators get one month, middle-level administrators get up to two months, and ASU workers get up to four months training.[52]

Minpribor has created an information-reference system to adjust software in the process of startingup. Minpribor also operates an organization out of Kalinin for the central supply of programs and algorithms for its computers. Rental of equipment eases the client's burden, because a dissatisfied lessee can easily divest himself of troublesome machines. The Leningrad Region Material and Technical Supply Administration under Minpribor rented measuring and control equipment to 1000 clients at 5 percent value per month in 1978.[53] Factory outlet stores, moreover, have appeared in both Minradio and Minpribor to study demand, to publicize new products and raise trade levels, and to trouble-shoot. Local trade ministries advocate such outlets strongly, as they shift the burden of facilitating trade to the production ministries.[54] Unwilling to leave the technology he helped create in the opportunistic hands of Minpribor, V.M. Glushkov, the

cybernetician, proposed an agency to act as a purchasing agent for ASUs just as the Ministry of Communication acts as a purchasing agent for the telecommunications sector.[55] One may gauge the prospects for this suggestion by the mixed success of Sel'khoztekhnika, the purchasing agent for agricultural equipment, discussed in the next section.

The interplay between clients and suppliers in the computer sector suggests that some officials are trying to reduce the adversary roles here that proliferate in other sectors. It is plausible to interpret this as an effort on the part of computer advocates interested primarily in rapid introduction and diffusion of the technology to get around the obstacle of client incompetence. If client competence were not an issue, it is hard to see why so many marketing initiatives should first have seen the light of day in a sector requiring extraordinary technical expertise. (Such initiatives have a longer history than the tenure of Rudnev at the head of Minpribor, so we cannot attribute it all to his energy.) In this context, client incompetence means technological incompetence. But the rapid development of a marketing or diffusion function in the computer sector may seem to be an attempt to get around obstacles posed by an incentive structure that rewards computer acquisition instead of computer applications, rather than obstacles posed by incompetence. Indeed, the computer sector might well benefit more from incentive reform alone than either of the other sectors studied here. The proper motivation of industrial managers to seek innovative ways to apply ASUs for streamlining industrial operations might, however, result in a taut market that would share the adversary characteristics, say, of agricultural machinebuilding or industrial construction. Without a price system to determine resource allocation automatically, the best intentions in the world might not improve outcomes in the Soviet computer sector.

A final case reinforces the suggestion that allocative problems in the computer sector go beyond the incentive structure. Some mainframe computers require two-tier, or false, flooring. The Central Scientific Research and Planning-Experimental Institute for Industrial Buildings and Structures rebuffed one unfortunate plant director seeking a complete interior for his computer center. They could only offer false floors, available in steel with a long waiting list at a Moscow plant or

in aluminum with a five-year waiting list (but requiring the client to supply the raw material) at Riga. Researchers at the Institute for Commercial Buildings agreed to design a new interior for the plant director--at a cost of 196 rubles per square foot and requiring ten tons of aluminum. They sent a request to Gosplan to allocate 20,000 tons of aluminum per year for computer room interiors. Gosplan reportedly told them "to think it over some more." Naturally enough, they designed a false floor of steel.

Both the Kurchatov Institute of Nuclear Power and the L'vov Elektron Association have large computers happily resting on wood-chip sheets. A woodworking enterprise can construct the entire floor at small expense, without consuming scarce resources, with no wait, and with the dignity of prosecuting a Soviet invention that Western interior designers are beginning to emulate. An official at the Institute for Commercial Buildings remarked: "Of course we know about the invention (of wooden interiors), we have known for some time. But we have rejected the wooden design: it's not modern." The Soviet author comments that they are strong-minded people at the Institute, not wishing to slip off the peak of scientific and technical progress. He concludes with the ironic suggestion that the Soviet Union start making aircraft from wood-chip sheets to save aluminum for computer room interiors.[56]

The case raises the question of what decision procedure allocates aluminum among rival claimants. If the fate of the Soviet Union's aluminum resources rests on bilateral adversary negotiation, no incentive structure can completely overcome the damage done by poor feedback to the decisionmakers ultimately charged with its allocation. Reform of the incentive structure governing the actions of rival claimants for scarce resources does not by itself guarantee an improvement in the usefulness of feedback from those claimants.

It is impossible to tell whether the level of investment in a new technology--be it imported or the result of domestic research and development--is too high or too low if the technology lacks practical application to gauge its worth. One group of writers at the Svetlana Association argues along these lines against the mass-production of microcomputers before clear industrial uses for them.[57] But if

decisions regarding investment result from a bargaining process in which client competence is more important than true client demand, then the sort of technological overinvestment that the Svetlana Association writers wish to deter will continue even if applications for novel technologies materialized in advance on the spreadsheets of planners all over the Soviet Union.

To summarize the discussion of Section II:

1. Clients' technical competence clearly affects Soviet industrial outcomes. This need not be the case. Many firms make a business of performing applications engineering for clients lacking any particular technical expertise. In his excellent overview of Soviet computing, Goodman writes: "IBM does not owe its continuing large share of the mainframe market to the technical superiority of its products, but to the scope and quality of its customer service and its aggressive concern for its customers' needs."[58]

2. What sort of decisionmaking system might result in such a sensitivity to client competence? Although the computer sector does not offer enough evidence to support a decisionmaking model, the prevalence of industrial disputes between its clients and producers suggests a role for an ad hoc arbiter. Goodman points out: "One of the most important of the self-assigned tasks of the Communist Party is to expedite all sorts of governmental and economic activities; it intercedes to get things done."[59] The evidence assembled here supplies a couple of examples; there are probably many others not discussed in the journal literature.

3. What difference would be made by reform in the incentive structure in the computer sector? If unarbitrated adversary roles do characterize Soviet industrial relations, the reform of incentives alone will not improve economic outcomes. The supplier must worry about the client putting up a smoke-screen of complaints if technological application proves difficult; the client will always try to get some free applications engineering out of the suppplier.

Taken together, the material gathered here casts doubt on the strawman position that the Soviet planning apparatus reliably detects domestic technological lags and soundly responds with investment in domestic research and development or even foreign technology. Such

detection and response, after all, requires extraordinary information and decision patterns. It is unclear that the Party, despite its interest in interceding to get things done, has the resources to pick up where the industrial decisionmaking system demonstrably leaves off. Once again, Goodman provides a synopsis: "The CPSU does not have the ability to exert pressure on behalf of each of the thousands of computer installations in the USSR, nor is it apparently interested in diluting its own unique strengths by letting non-Party organizations exert such pressures."[60]

III. AGRICULTURAL MACHINEBUILDING

The Soviet agricultural tractor sector suffers from too much horsepower and not enough reliability and rejuvenation of older machines. This is probably the effect of a supplier following the path of least resistance and a client failing to provide responsible feedback. The pricing system protects farmers from the increases in wholesale prices that reflect equipment upgrades: Farmers pay retail prices that remain fairly constant from year to year. For this reason, the buyer's cost share of price differences between old and new machines is zero. The other characteristics determining client feedback balance out. Some argue for greater client concern about tractor and other farm equipment supply and thus for more useful feedback on tractor effectiveness; some argue the reverse. Substitutes for extra tractor power exist but are not cheap; the center exerts pressure on agriculture but diffuses it over the equipment suppliers as well as the farmers; agricultural output is sensitive to tractor performance although climate and soil quality probably mask the effect; and change in the basic technology is slow-paced (although accessory equipment technology appears to be changing rapidly). All in all, the main characteristic in the balance remains the lack of user financial responsibility for price differentials between old equipment and new upgrades, creating user feedback that misdirects farm equipment suppliers and causing the adversary system to misinform the center on agricultural equipment needs.

With agriculture, the Soviet Union puts its worst foot forward. As a consequence, the sector receives much diagnostic attention in the Soviet press, providing abundant material to document the adversary system. The presence of a central purchasing agency for farm equipment, Sel'khoztekhnika, complicates the relationship between farmers and agricultural machinebuilders and offers a variation on the pattern of incompetent consumers found in the computer sector.

With each annual Soviet agricultural shortfall, blame falls on the size and power of the Soviet tractor park. Although Soviet perception and resolution of industrial problems is the proper focus of this study, it is worth comparing Soviet and American outcomes in tractor production and maintenance for the sake of perspective. In 1975 the Soviet Union produced more than twice as many tractors as the United States, albeit of lower average horsepower.[61] The number of new tractors, therefore, does not promise to explain shortfalls in Soviet agriculture on its own. Shortage of spare parts might be a problem, but spare parts production turns out to favor Soviet performance: Rubenking writes

> Soviet spare parts production in 1974 was roughly equivalent to 350,000 new tractors, whereas U.S. spare parts production, for the same year, was the equivalent of about 64,000 tractors.[62]

(Soviet demand for spare parts still managed to outrun supply.) Even tractor retirement rates are comparable in the two countries, although Rubenking notes that the United States can better afford this as its park has long been near saturation.[63]

One possible conclusion is that Soviet tractors must be technically retarded compared with their American counterparts for large disparities in agricultural outcome between the two countries to persist. The fact that the Soviet Union principally imports not agricultural tractors but specialized, high-powered tractors for industrial applications--such as laying gas pipelines, ripping ground in permafrost regions, and forest-clearing[64]--suggests that the most challenging applications do draw foreign technology. But the Soviet Union is importing tractors for use precisely in those sectors where Sel'khoztekhnika and the state farms do not play the role of customer. This section pursues the hypothesis that the nature of the customer strongly influences both the successful use of technology and the decision to repair or retire old tractors. The adversary bargaining relation between the Soviet client and supplier (in this case either Sel'khoztekhnika or a Soviet foreign trade organization) ultimately links client characteristics with industrial decisions.

INDUSTRY STRUCTURE

Investment Policy

Soviet policy has emphasized the importance of expanding and modernizing the capital base of agriculture. The scale of investment has been extraordinary. Annual agricultural investment quintupled between 1960 and 1980, reaching a quarter of the nation's total (compared with 4 percent for the United States).[65] An article written in 1977 declares as a goal of CPSU agrarian policy the "complete mechanization and automation of all production processes."[66] Many Party declarations look clearly to the agricultural machinebuilders to rescue agriculture. The pressure in agricultural equipment construction has consistently been on the supplier.

The supplier has reacted to this pressure with strong statements of intent to fulfill ambitious output targets. The Ministry of Tractor and Agricultural Machinebuilding, Mintraktor, has been able to keep fairly close to these output targets, in some cases: In 1974 it announced the intention to produce 575,000 machines and fell short by only 4 percent. The figure is typical for the early 1970s. The ministry has stated the desire to raise tractor power, to develop new grain harvesting combines, and to produce plowing and industrial tractors and machines for lumber (the country, as noted above, has had to import machines in the latter three categories). To this end, Mintraktor's principal plants have stepped up development of heavy tractors for industrial use. The Chelyabinsk factory began work on the 160 hp T-130 tractor. It undertook, in addition, the design of several supertractors (220 hp, 300 hp, 500 hp Bogatyr-type tractors) for production at the new plant in Cheboksary.[67] The Tenth Five-Year-Plan (1976-1980) had Minzhivmash, the Ministry of Machinebuilding for Animal Husbandry and Fodder Producion, increasing production of pick-up balers, grass-meal preparation equipment, milking units, feed distribution mechanisms, cleaning equipment, and large-scale livestock-handling equipment. The plan called for an increase in the ministry's stock of integrated sets of equipment from 35 to 72. In addition to quantity, the ministry expected to emphasize quality in its new products: the percentage of products receiving the state seal affects a branch's ability to secure internal reserves within a ministry.[68]

The Ministry of Agriculture (as the ultimate client of the agricultural equipment sector) includes some big fans of heavy industrialization as the cure for the Soviet Union's agricultural ills. The chief for the Use of Machines in the Ministry of Agriculture, for example, defines technical progress as increase in the unit capacity of machines, machine specialization, development of sets of machines for production line mechanization, electrification, microclimate control, breeding equipment development, design of industrial monitoring equipment, and development of automatic flow lines.[69] Power-worker ratios (which reach 20,000 kW-hours per year in mechanized farms and 150,000 kW-hours per year in industrial complexes) and labor-hours expended per unit of product are key criteria for assessing agricultural progress, according to this official.[70] Both of the criteria he mentions are partial: Power-worker ratios neglect the cost of electrification and the utility of power capacity in agriculture, and labor-hours per unit of product neglect the cost of capital in minimizing worker time. The emphasis on unit costs rather than marginal costs is a mistake shared by U.S. Federal budgetary practice--it is possible to minimize average costs at a level where marginal cost and marginal benefit remain greatly out of line. Where both the ultimate client and the supplier agree on more, bigger, and better, one is unlikely to find anything other than massive investment in equipment to the possible prejudice of better allocations of the sector's resources. An alternative is greater expenditure on prolonging the lives of tractors due to be retired. So much premature retirement of agricultural equipment in the Soviet Union may be testimony to effective bargaining on behalf of sovkhoz tractor operators who like new machines.

One of the largest planning problems with the current Soviet tractor fleet is the lack of complementary equipment. The K-701 tractor is 2.7 times more productive than the DT-75, but five times more costly, as it requires "a complex of appropriate mounted and drawn implements" with combined operations. A Gosplan official remarks: "All of this . . . requires a well-defined scientifically formulated system of machines and implements which, unfortunately, we do not presently possess."[71] Brezhnev criticized the K-701, along with the K-700 and the T-150,

because their trailer attachments were coming off the production line too slowly and their efficiency ratings dropped sharply when used with smaller trailers designed for other machines. This has given rise to a generation of self-propelled combines, including the curious SKP-2, which is designed to pick tomatoes and separate the red from the green with a possible application (?) to onions, peppers, and cabbages.[72] The state of the fleet of K-700 tractors (the predecessor to the K-701) puts in perspective the hopes for the current machine: Only 60 percent were still operating in 1975, 20 percent were "correcting trouble," 13 percent were at "technical standstill," and 6 percent were inoperative "for organic reasons."[73] Such an inoperative rate for a new tractor in the taut Soviet agriculture sector prompted a surge in larger tractor production without attention to balanced planning of whole sowing and harvesting systems. We must ask why farmers' needs do not feed into the planning system.

Organization

The Cheboksary Tractor Plant, a new enterprise that has undertaken production of 220-500 hp Bogatyr-type supertractors, has been having trouble that offers an insight into organization and planning in industrial startups. Although the general contractor and not the purchaser is primarily responsible for the "introduction of (industrial) capacities," the Cheboksary plant directors must share the blame for the delay of construction of several new production areas at the plant. The plant altered plans for its prospective paint shop partway through construction without supplying the nonstandard equipment it was building for the construction contractor. The plan changes were a response to defects in the work by the Khar'kov project planning organization and its Saratov subcontractor. The article writer suggests the plant planners are responsible for their tardy recognition of the errors in the incoming plans. However, the writer met the senior job supervisor of a construction administration responsible for completing hook-ups in a welding shop. Asked why no workers were to be seen on the site, he "looked at his watch as if to say it was lunch time. But at my suggestion that we wait for them to return, he acknowledged that the workers had been transferred to a different sector." The supervisor's

manager was unable to explain the transfer. This is simple shirking on the part of the contractor.

The writer proposed careful monitoring of the welding shop operation by the Cheboksary City Party Committee. The City Committee balked, as its division of construction and municipal services was unsure whether the state commission's affidavit accepting the production areas according to the original (1978) plans had been ratified. The article writer condemned the lack of constant monitoring by Party bodies and the mutual irresponsibility of the purchaser and contractor.[74] The upshot of the article, incidentally, was for the Cheboksary City Party Committee to agree that the plant directors irresponsibly altered construction plans and that the contractor failed to organize the work properly. The Committee reportedly intensified its monitoring operations at the tractor plant.[75] The Cheboksary Plant is hardly a minor operation, so the project is unlikely to suffer from lack of priority. It appears that both the purchaser and the contractor, in this case, required discipline from the City Committee, as well as arbitration and general administration. The City Committee is either incompetent or overburdened. This is an example of judicial backlog in an adversary system that cannot afford it.

The management of industrial organization seems to create problems for Mintraktor. Plans called for the Belorussian Tractor Corporation to incorporate seven plants surrounding the Minsk Tractor Plant. These plants were subordinate to four different industrial administrations (glavki). Only the four likeliest plants ever came together, because the administrations protested the loss of subordinate plants, and "plant directors . . . would not protest against the wishes of their main administrations."[76] The plant directors evidently had reason to fear the administrations they would be leaving behind.

In another case, an author from the All-Union Institute of the Mechanization of Agriculture complains of the subordination of Mintraktor enterprises to several agencies controlling material allocation. Better by far for one agency to regulate all supplies. (That this is not the case may reflect the difficulty of monitoring an operation with one coordinated supply channel. The proliferation of supply authorities causes disputes that are easier to check, if not to

arbitrate.) The author of the source article documents GKNT action that split his research project between Mintraktor and the Academy for Agricultural Science (VASKhNIL), with the result that the project failed to produce a method for increasing tractor speeds. As a consequence, he claims, the Soviet Union has no high-speed inter-row cultivators, no tools for the MTZ-80, and delays on the T-150.[77] His perspective makes his assessment unreliable, but the organizational problems are clear.

Repair and re-use of obsolescent tractors is another way to reinforce the farm machinery sector, but one that the Soviets do not exploit. This is surprising, because one commentator writes that new production cannot reduce the fleet deficiencies by more than 30 percent and sooner than in one amortization period (eight years' time). He suggests redistribution of the fleet after tractors have undergone repair work. Sel'khoztekhnika could distribute all new models in bulk to the strongest farms rather than supplying a few units to each farm. The weaker farms would acquire used models. Such a practice would correspond to current British and American practice, where cash-rich farms can invest in new equipment while re-selling old equipment to cash-pinched concerns.[78]

Research and development, as the Party Central Committee declarations all suggest, is a crucial input in the agricultural machinebuilding sector. The research, moreover, is not entirely at the level of technical engineering. The elevated Academy of Agricultural Science (VASKhNIL), for example, declares its goal to include the satisfaction of food requirements, increase in food quality, increase in the effectiveness of production, increase of labor productivity, the transformation of agriculture into an industrial sector, decreased dependency on the weather, the transformation of the relations of production (private to public), the elimination of disparities between city and country, and the protection of the environment.[79] Regrettably, there is no category addressing tradeoffs among these goals, such as between transformation of the relations of production and satisfaction of food requirements.

More than this, however, sheer abstractness complicates the R&D function in agriculture. The 150 research and design institutes and technical bureaus, the 21 higher educational institutions, and the

80,000 researchers of the city of Khar'kov saw 35 percent of their research projects implemented in 1971; the Ukrainian Scientific Research Institute of Agricultural Machinebuilding had a record of 10 in 26 technological deployments. One of the reasons given that the numbers are not higher was the lack of experimental production facilities in the city. The Khar'kov Party City Committee and the Interindustry Territorial Center of Scientific Technical Information and Propaganda held a conference on the subject, recommending *khozraschet* and improved implementation incentives.[80] "It is not Minerva, however, but Vulcan who tends the forge."

This is not to suggest that an army of pragmatic-minded researchers would cure Khar'kov's problems with implementation of research developments. Consider the case of hardened piston rings at the Research Institute of Technology of Tractor and Farm Machinery Construction. The Institute Director, Ignatyev, approved a cooperative project with Avtodizel (a research and production "corporation") in 1971 to try to increase the life of piston rings. An Institute associate, Vaystukh, approached Avtodizel deputy director V. D. Arshinov at Avtodizel's Yaroslavl plant. Vaystukh's calculations suggested that special hard coatings might double the longevity of piston rings and reduce fuel and oil consumption, with a resulting savings approaching 5 million rubles for the auto industry alone. Arshinov was interested. Ignatyev apparently incorporated the project in the Institute's 1974 plan, but suddenly issued a stopwork order several months later. An Avtodizel chief asked the Institute why work had ceased when he in fact wanted to accelerate the project. The Ministry of the Automotive Industry had expressed willingness to invest R 300,000 in the project. The Institute's welding chief, a supporter of the project, showed the Avtodizel letter to Ignatyev, whereupon the Institute director fired him. The Ministry of Agricultural Machinery (now split between Mintraktor and Minzhivmash) supported Ignatyev in the contention that the project was never formally part of the Institute's research program--it was Vaystukh's private work. Thus Ignatyev seemed to be concerned that he would be responsible for research outside his control. The Ministry of the Automotive Industry reassigned the work to another institute.[81] Questions of turf and bureaucratic property can impede innovation as much as unpragmatic research.

Soviet commentators are clearly very sensitive to these turf battles between institute and enterprise directors in various ministries. The theme of resentment toward administrative barriers interfering with scientific or technical progress recurs frequently, but unaccompanied by any attempt to explain the importance or origin of those administrative distinctions that make up the ministerial system. Jerry Hough and John Moore, in their different ways, have each suggested that the turf battles and adversary relations arising from ministerial and branch organization serve a direct purpose related to the maintenance of Party control. Hough argues that the prefectural system prevents the formation of stable, bureaucratic, autonomous lines of command; Moore believes the failure of the Soviet system to innovate is small compared with the savings in agency costs that it enjoys. The present cases in no way dispute these generalities, but try instead to characterize the decisionmaking process that inspires so many abstractions and general observations. The following reported comments on the status of the design organization illustrate the response of an industrialist to the many complex and confused sets of overlapping jurisdictions that create the adversary system in Soviet industry.

It is apparently the duty of the Academy of Agricultural Science and the USSR and republic Ministries of Agriculture to specify requirements for new technology; the design bureaus of Mintraktor attempt to build prototypes in accordance with these specifications. Design bureaus, according to one commentator, should therefore have authority over projects straddling several branches of agriculture. Along the same lines, he argues, R&D centers within production corporations should be independent subdivisions. The managers of these institutions, accordingly, require expanded authority, so as not to be dependent on the authorization of a single industrial branch for supplies. These managers should also be able to call on talent from other organizations. Only the ministry (and not the branch or administration chief) should appoint a design bureau director. The director needs both the right to represent his organization in technical planning for the ministry and the right to establish business contacts.[82]

This commentator is seeking a design bureau director in a position to overcome adversary disputes affecting the bureau. We may similarly interpret the drive to append research institutes (NIIs) to plants and to attach experimental plants to NIIs as an attempt to bring one set of adversary relations--those between researcher and producer--under one reliable arbiter (namely the director of the original organization). Other forms of industrial integration abound in the agricultural machinebuilding sector: There are inter-enterprise establishments created through the finances of shareholder institutions; agro-industrial enterprises, or mechanized farms; production associations consisting of administratively independent member institutions; production agro-industrial associations; and of course the scientific-production associations mentioned just above.[83]

Whether we wish to regard these forms of integration as effects of the adversary system or even attempts to evade it, we must recognize that they are altering the landscape upon which any industrial decisionmaking system rests. There is no evidence to suggest these forms of integration will succeed in improving arbitral procedures for conflict resolution. But the attempts themselves testify to the handicap imposed by the lack of such procedures. One commentator even tries to quantify the loss to agriculture due to the bureaucratic, pre-integrative, "branch" approach: The branch approach, he contends, encourages departmental autonomy and thus sub-optimization. This has arguably caused a shortage of grain-harvesting equipment, resulting in a 20 percent loss of grain in some oblasts; and a shortage of transport vehicles and poor roads, resulting in a loss of 3 - 5 percent more grain and 10 percent of the sugar beet crop.[84] This puts the cost of maintaining Party control through a system of monitored chaos quite high.

Foreign trade has complemented agricultural equipment development in some cases. The deals are often quite specific with respect to geographic area and technological application. For example, GKNT agreed in 1977 to import vegetable farm equipment for Moldavia from the American company, FMC. More interesting is the continuing role of Sel'khoztekhnika as quality controller in these transactions. Thus

Krasnodar stations tested the John Deere "HR-50" before accepting it for import. As a result, foreign firms must maintain good relations with Sel'khoztekhnika even though the latter agency does not purchase foreign equipment.[85]

Prices

Prices and costs are important in determining outcomes in the farm machinery sector, too, although prices tend to supply information (of a sort) to planners rather than rules for deciding whether to buy or sell. Price per unit of power serves as the criterion for justifiable increases in the prices of wholesale equipment. (This may seem rather inflexible, but it probably guards against goldplating.) The KKS-6 castor-oil plant harvester, for example, replaces the KKS-4 with a price of R 12,280 (for industrial buyers)/R 9935 (agriculture) rather than the previous R 9000/R 7650. KKS-6 productivity is 1.18 hectares covered per hour as against .93 hectares/hr for the KKS-4. (Here a 27 percent gain in productivity earns Mintraktor a 30 percent increase in price.) The new equipment, it is noted, prevents losses during harvesting that do not figure in the productivity indexes.[86] Thus Mintraktor seems to be supplying a little something for nothing. (Indeed, Mintraktor machines have begun to penetrate American markets, although this may be the effect of central agency dumping more than of cost-effective production.) Whether or not capital productivity always improves with new models, it is reasonable to look to the cost of labor in agriculture if one wishes to claim that the Soviets overinvest in agricultural development (or, more accurately, that their investment policy is seriously unbalanced). The idea that labor productivity might be the main problem in agriculture accords with the view that the Soviet incentive structure on kolkhozes and sovkhozes needs drastic improvement. But the Ministry of Finance disagrees.

Price disparities, noted one Finance official in 1977, reduce effectiveness of machine deliveries. Sel'khoztekhnika organizations paid wholesale industrial prices (set 1 July 1967) for the machines they intended to distribute. They sold the equipment at lower retail prices (set before 1967) to kolkhozes, sovkhozes, agricultural enterprises and organizations. Sel'khoztekhnika received reimbursements from the state

budget for the difference between "wholesale" and "retail" prices. (Gosbank grants credits before the reimbursement.) This price differential was to disappear as learning effects brought tractor production costs down. The differential increased, however, because of goldplating. Between 1969 and 1976, wholesale prices rose 69.7 percent for mineral fertilizers (also handled by Sel'khoztekhnika) and 89.2 percent for agricultural equipment. The wholesale-retail deficit rose 251.3 percent for mineral fertilizers and 114.3 percent for agricultural equipment. The Ministry of Finance naturally thinks retail prices should rise to match wholesale price increases--naturally, because the consumers would then bear part of the increasing deficit, which the Ministry of Finance otherwise shoulders alone. Reimbursements to Sel'khoztekhnika reflecting the deficit between wholesale prices (paid by Sel'khoztekhnika) and retail prices (paid by the kolkhozes and sovhozes) amounted to 4.7 percent of cost for the DT-20, 9.5 percent for the MTZ-50M, 21.3 percent for the DT-54, 30 percent for the Kolos and Niva grain harvesters, and a staggering 50 percent for the T-150 tractor (R 10,500 industrial/R 6500 agricultural).

Given all this, one might expect the official simply to insist that users pay for tractor improvements. But the official suggests there is no incentive for farmers to become discerning and exacting consumers who make efficient use of their equipment when they bear no cost of improvements in the tractor fleet.[87] If retail prices were flexible, farmers would sit up and take notice of the proposed alterations in farm equipment. They are certainly in a better position to evaluate such alterations and to distinguish between true technological advance and goldplating. Sel'khoztekhnika is in a similar position but has no incentive to evaluate product changes because it bears no responsibility for its own budget. The financial arrangements for the agricultural machinebuilding sector have the effect of transferring some of the adversary relations naturally occurring between farmers and equipment producers to Mintraktor and the Ministry of Finance. The Ministry of Finance would like to shift them back again to the farmers. The notion of an adversary system helps us understand this development.

The Ministry of Finance has a watchdog role in the economy involving it in adversary relations that may be particularly marked in agriculture. In 1977, the RSFSR Council of Ministers ordered its republic units of Minfin (Finance), Gosbank, and the Statistical Administration to strengthen financial discipline. RSFSR Minfin annually audits 1200 agricultural projects, 1000 of which fall under the jurisdiction of the RSFSR Ministry of Agriculture. R 11 million in illegal wages accounted for half the violations uncovered in 1977. Spoilage, squandering of stores of produce, and cheating of kolkhozes and sovkhozes by the organizations supposedly serving them also contributed. Violations occurred in the procurement and installation of agricultural equipment and in the course of water-management construction. Minfin criticized the Ministry of Agriculture for issuing a statute awarding bonuses to workers in computer factories under its jurisdiction.[88] In summary, the Ministry of Finance has reason to be concerned with the efficiency of capital consumption in the agricultural machinebuilding sector, having to pay for abuses of capital funds such as goldplating.

Labor

One of the problems in regulating the employment of labor resources in the Soviet Union is the accurate description of those resources. Between 1966 and 1978 agricultural production costs rose 41 percent. Sovkhoz and kolkhoz wages both rose more than 100 percent in this period. Labor productivity rose 70 percent by one estimate.[89] Labor costs, therefore, would seem to figure prominently in the increase in overall cost of agriculture. The mix of workers in agriculture has changed as well. Between 1964 and 1976 the percentage of machine workers in the total agricultural work force rose from 12 percent to 18 percent, with an accompanying increase of more than 50 percent in worker productivity.[90] The source for these statistics implies that the increase in proportion of machine workers has caused the increase in overall labor productivity.

Labor productivity is key partly because planners base capital allocation decisions on it (together with production costs of output). This practice not only ignores changes in the production function, but assumes a meaningful measure of output. The following figures juxtapose labor productivity in agriculture with other indexes:

	1966-70	1971-75	1976-80
capital investments	100	166	213.7
fixed production capital	100	173.8	262.2
workers (public sector)	100	96	92
capital/labor	100	181	285
gross output	100	129.3	160.8
labor productivity	100	134.6	174.8
output/capital	100	74.5	65.4

The writer providing these statistics notes that the capital-labor ratio for agriculture has consistently been half the industrial ratio, whereas in the United States agriculture is three times as capital-intensive as industry. He is unworried about continued contraction of the labor pool. Implying that repairs fall under "capital investments," he explains the reduction of the output-capital ratio as an increase in repair services relative to output. The further assumption seems to be that the funds spent on repairs might have been diverted to further tractor production. He assumes further tractor production might have increased output in the short term more than repairs increased short term output, and the output-capital ratio might not have fallen as much as it did in the latter period. The short-term loss in capital productivity may result in a long-term gain from a better and more cheaply maintained tractor fleet. So far so good. But in conclusion, he prescribes as a condition for capital investment that each percentage increase in the capital-labor ratio must effect a 1-1/2 percent increase in labor productivity.[91] There is no attempt to trade off the value of further repair services against the value of further tractor production. The entire focus is on replacing labor any way possible.

The contraction of the labor pool does have productivity implications because it partly reflects dissatisfaction on the farms. Typical are the following lines:

> One of us took courses to operate the K-700; the other received an old tractor. Both of us, it turned out, did not have a real function. The first, having received a license to operate a powerful machine, works as a carpenter or as a trailer operator; the second is constantly repairing his machine. But we have to feed our families and get on our feet, after all. With our present wages this is impossible.[92]

The upshot of the unattractive work conditions on kolkhozes and sovkhozes is a labor shortage on the farms. Industrialization of the sector only exacerbates the problem: "The high degree of mechanical labor inherent in large-scale production operations also limits the possibility of attracting juveniles to work in agriculture."[93] Pensioners can work only on private plots, particularly if they are unprepared to take on the housing problems agro-industrial complex workers must face. Given these considerations, it is natural to ask why authorities do not encourage small, widely dispersed, marginal farming in backyards. A commentator points out:

> The private economy does not divert workers from public production (as is sometimes thought), but rather it makes it possible to employ that manpower which cannot be employed in large-scale agricultural production.[94]

It is not surprising that there is a private sector in agriculture, but it is that the government perpetuates the disadvantages under which it labors.

CLIENT-SUPPLIER INTERACTION

The private sector provides examples of the interactions that characterize client-supplier relations in all of agriculture. Only 1 percent of the families in Estonia own small garden tractors; fewer own milking units or dung-loaders. One third of the cattle owners have

water pumps, half have watering equipment of any sort.[95] Most Soviet writers regard Estonia as the most advanced agricultural producer in the Union, so shortcomings here are likely to be far worse in Kazakhstan. None of this would matter, of course, if private farming were insignificantly small. But private plots in 1977 accounted for 12 percent of the overall volume of agricultural production, 27 percent of all vegetables, 30 percent of all meat and milk, 37 percent of all eggs, and 62 percent of the potato crop. The only widely available mechanical aids these farmers have are pumps, electrical separators, butter churns, and straw cutters. The Russian Republic Union of Consumer Societies, the supply agent for private farms in the RSFSR, appears to have difficulty procuring basics such as fertilizer from the chemical industry (Minkhimprom).[96] This ultimately reflects Soviet ideological problems with private farming. But we can regard the supply shortfalls as the immediate result of adversary negotiations between a weak client and perhaps politically maladroit client representative on the one hand, and a supplier with political clout and demonstrated negotiating skills on the other.

The Minsk Oblast Party committee has coordinated an impressive effort to develop a miniature tractor suitable for private plots. The Minsk Machine Tool Plant "Kirov" produces the steering; the Borisovka plant is responsible for the differential; an enterprise in Vilnius manufactures the gas tank. Needless to say, geographical dispersion hampers development despite the best efforts of the oblast Party committee. One writer claims that his plant could solve the entire problem of miniature tractors by designing auxiliary equipment for the MTZ-0.5 provided only Gosplan consider the tractor to be the plant's principal product.[97] This adversary dispute between an enterprise and the state planning agency was unresolved in 1981.

A highly publicized article in *Trud* (1977) documented the success of the Czech firm Agrostroy and the Hungarian firm Kompleks in manufacturing small, convenient garden implements, asking why the Soviet Union could not do as well.[98] There was a definite response, and the Eleventh Five-Year-Plan pushed production of these items. In 1981 470 plants manufactured orchard and garden tools and attachments, but these enterprises are distributed among 69 ministries and departments,

indicating lack of the concentrated effort and priority that characterize the more centralized, and usually successful, Soviet economic campaign (such as the gas campaign). If Mintraktor is conducting a "unified technical policy" to meet the public's demand for garden implements during the current five-year plan, so far this has amounted only to the distribution of a catalogue of proposed tools and instructions for production. Writes one Mintraktor commentator:

> But by no means is the head industry always able to compel the enterprise of another department to abide by the prescribed procedure in manufacturing products that are in our list. Cases are not uncommon where "outside" plants curtail or altogether cease production of orchard and garden tools without consent of Mintraktor and put products into production as they see fit. [99]

Here is a classic case of an adversary relation--this time between production ministries--with no clear rules for deciding a conflict of interests. It is time for one of Jerry Hough's Napoleonic prefects to step in and decide the matter.

Production of garden implements would be useless without a cooperative distribution network. In this, Mintraktor adopts an adversary role with regard to the Ministry of Trade:

> It is not uncommon for a plant to increase the output of a certain type of product for which the demand is far from being satisfied. But the wholesale depot with which the plant has a contract opposes a further growth of production. The Lidsel'mash Plant in Grodnenskaya Oblast planned in 1981 to increase the output of hoes to 90,000, while the request from the trade sector was only 25,000; that is, that was the number of hoes the market needed according to the wholesale sector. The production association Voronezhzernomash found it possible to increase the production of orchard augers, but once again trade organizations have not been supporting this initiative, though according to figures of the USSR Ministry of Trade, the need for these goods is far from satisfied.[100]

Such accounts do not analyze the motivation of trade organs to impede distribution of a good, although we may surmise the goods are not in the trade organ's plan. This would support the model of decisionmaking from a mesh of conflicting, unarbitrated interest groups.

The Russian Republic Agricultural Trade Cooperative is trying to create a series of local stores specifically for the distribution of shovels, milking units, plows, fertilizer, toxic chemicals, and building repair materials. (This organization may be subordinate to the republic Union of Consumer Societies.) There are 12,000 "household goods" stores, 58,000 stores "for goods in daily demand," 500 warehouse stores, and 100 house and garden stores. Smolensk Oblast has been particularly successful because of its oblast consumer union. Individual trade organizations, however, will push expensive goods in order to fulfill sales plans. (Does this explain the troubles Lidsel'mash encountered with its trade contractor?) For this reason, the RSFSR Union of Consumer Societies proposes that rayon consumer unions should distribute garden tools at produce procurement points, bypassing the Ministry of Trade.[101] Consumer marketing seems to baffle the Soviet system. The adversary relation between the Ministry of Trade and the consumer unions may have some beneficial effects, but the present lack of adjudication between distribution interests and consumer interests produces only confusion and inaction.

Repair work provides another field for the development of adversary relations in agriculture. Malfunctions seem to plague Soviet tractors. In Belorussia, Sel'khoztekhnika operates repair enterprises, technical servicing points on kolkhozes and sovkhozes, and repair stations and repair shops. The Belorussian Communist Party blamed Belorussia's 30 percent inoperative vehicle rate on "large misreckonings" of Sel'khoztekhnika. Gosplan, the Ministry of Agriculture, and Sel'khoztekhnika were held jointly responsible for the inadequacy of repair facilities, which averaged a 26 percent defective repair rate in 1977.[102] This raises the important question of whether Sel'khoztekhnika actually encourages the diffusion of Soviet agricultural technology or merely multiplies the number of adversary roles bedeviling the sector.

Another example of adversary roles involves the conflict of interest between sovkhozes and kolkhozes on the one hand, and enterprises responsible for providing trucking and transportation services on the other. This area has the beginnings of a decision

system, but the details have yet to be worked out. A motor vehicle establishment charges farms 3.5 to 10 kopecks for each idle minute on 4-ton and larger trucks. Farms charge motor vehicle establishments 2.5 kopecks for each minute late a vehicle arrives for work. If the truck is more than 30 minutes late, the establishment pays R 1.50. Fines in the Ninth Five-Year Plan period (1971-75) amounted to 40.3 million rubles.[103] The Soviets are actively seeking an alternative to trucking: TASS reports that container pipes can replace 60,000 drivers and 20,000 10-ton trucks yearly.[104]

Several cases involving grain elevators illustrate the importance of clients occasionally acting as advocates to get things done for a supplier. These large structures store and occasionally process grain between harvest and eventual consumption. Without adequate storage facilities, a harvest is wasted. The Tenth Plan called for a doubling of the Ninth Plan's elevator base. The Party blamed lags in 1976 on the contracting organizations for the USSR Ministry of Construction and the USSR Ministry of Industrial Construction.[105] Other sources criticize the USSR Ministry of Rural Construction for dilatory incorporation of new technology. Lags of up to eight years have delayed the introduction of ring-shaped silos, prefabricated monolithic foundations, and metal silos.[106] Orenburg province, with its large volume of grain production, needs vast elevator capacity. Grain is piling up, often completely exposed, at places like Novosergiyevka. The deputy director for construction at Novosergiyevka and a foreman at the Orenburg Elevator Construction Trust cite a shortage of labor (96 rather than 250 workers) as the principal problem. A meeting attended by the chief of the Main Administration for Elevator Construction in the RSFSR Ministry of Rural Construction, the director of the Orenburg Elevator Trust, and a "representative of the client" resolved the labor shortage. The resolution does not seem to have required Party intervention, but it also does not seem to have been routine procedure. [107]

Equipment rather than labor shortages have plagued the elevator combine at Ussuriysk, Primor'ye province in the Far East. The elevator handles 18,000 tons of mixed feed every month for the entire southeast part of the Soviet Far East. The Ussuriysk elevator is the only one in the area. Yet it had lacked 56 unloading sections for the main grain

conveyors, four chain conveyors, actuating boxes and cables. The RSFSR Ministry of Procurement supposedly placed priority orders. When the equipment did not arrive, the combine director traveled to the Odessa Prodmash Plant, which was simply slow in delivering its conveyors, and to the Khar'kov Spetselevator plant, which had never even received the orders and had no indication that Ussuriysk was a priority project (implying such information would have made a difference to production decisions taken at Khar'kov). The commentator writes:

> It would be unfair to accuse the Primorskiy Kray Grain Product Administration (the client) of total indifference to the situation in Ussuriysk. It is perfectly apparent, however, that had the clients demonstrated greater foresight and persistence the "joining" of plans of the builders and those of the suppliers would have been more dependable. This is the cost of a lack of coordination in planning even though the builders are enthusiastic.[108]

This variation on the theme of adversary supplier-client relations suggests that the supplier occasionally looks to the client for support in procuring equipment for capital construction. In another case, the Tselinograd Elevatormel'stroy Trust asked to abandon plans to produce elevators of a new design involving mobile molds of monolithic concrete that do not admit moisture as readily as older models: the producer is not always enthusiastic.[109]

Explaining overall difficulties in the elevator campaign, A. Maslov writes:

> Neither the USSR Ministry of Procurement as the customer nor the USSR Ministry of Rural Construction as the main contractor were prepared . . . for implementation of a rapidly growing program.[110]

The implication of Maslov's lament is that things might have turned out for the better in the grain elevator sector if at least one interest group had supported expanded production. But with an indifferent client, and an occasionally balking producer, it seems there has been no natural mechanism to push the technologies involved. The Ministry of Agricultural Construction, in partial recognition of the lack of

interest group advocacy of the program, assigns staff that make monthly visits to each elevator and report to a ministerial board including representatives of the client. Furthermore, there is an all-union staff headed by a deputy minister for agricultural construction and a deputy minister for procurement, and attended by managers of construction trusts, deputy chiefs of oblast administrations for grain products, and central services of the contractor and customer. "[I]f a shortage . . . is experienced . . . then specific measures are adopted on the spot jointly with the customer to eliminate the difficulties," writes a commentator.[111]

The creation of a central panel to adjudicate industrial disputes is a logical response to the problems in Soviet nondefense industry. But there is a tradeoff between high placement of such an adjudicative panel enabling it to implement decisions, and the dispersion of authority necessary to manage all aspects of the diverse operations of the elevator construction trusts. A standard decision procedure would harness the information available from the working of the adversary system in Soviet nondefense industry in such a way as to avoid this tradeoff: Decisionmaking could be both efficacious (the interest groups or adversaries would see to that) and sufficiently articulated to meet diverse needs (because the decisionmaking participants would all be local players).

A final agricultural support sector that gives rise to interesting industrial disputes, and also to a demand for foreign production processes, is chemical fertilizer. A July 1978 Central Committee Plenum decree concentrated agrochemical services into the center and branch administrations of the agricultural machinery repair and maintenance network. The agrochemical production base had since 1972 consisted of centers at farms coordinated by interfarm centers. There were, for example, 305 centers at Ukrainian farms and 198 interfarm regional associations, in addition to 210 "special sections" attached to Sel'khoztekhnika. We know a little about the development of some of these cooperatives. A former chief of a rayon Party directorate for agriculture (now first secretary of another rayon Party committee) formed the first cooperative center financed entirely by shareholder kolkhozes: Established in 1975, it services 17 farms with three

agrochemical centers, labs, an information center for epidemiological tracking, a supply service, storage space for fertilizer and pesticides, and mechanized equipment for the maintenance of pastures. A kolkhoz council directs the center, assisted sometimes by Sel'khoztekhnika. The agrochemical center determines fertilizer demand, prepares orders, and controls storage and distribution. It also limes and sprays the fields. Large farms have their own centers; otherwise interfarm associations with jurisdiction over 20,000 hectares (10-12 km radius) with three to four local centers each seem appropriate.[112] An official in the Ministry of Agriculture with responsibility for the use of chemical processes notes that shareholder ownership of the agrochemical associations "makes it possible to control the economic interrelationships, the price level for services and the distribution of profits."[113] He might have written that this arrangement prevents a set of adversary relationships from developing between the equipment procurement centers and the farms, as has happened in some instances with Sel'khoztekhnika.

The supply of fertilizer, nevertheless, has serious problems. A Gosplan official claimed in 1978 that 20 to 40 percent of all fertilizer deliveries were unsatisfactory. Shortfalls centered on moisture content, acidity, caking, lack of potency, low granule strength and unsuitability for bulk transport.[114] Another problem has been beyond the control of ministries alone: The nonchernozem (non-black-earth) zone of the Soviet Union is poor in phosphates but rich in phosphorites. Phosphorites fertilize only when limed. The decision to develop nonchernozem farming together with a history of difficulties with phosphate production that have persisted despite Western technological assistance since the 1930s have caused Soviet foreign trade organizations to import a large quantity of super-phosphate fertilizers from the Occidental Chemical Group. These large imports have not created a dependency on Occidental because the Soviet Union always entertains the expensive option of a campaign to lime nonchernozem soil extensively. The decision to import chemical fertilizer comes close to purely technological considerations. But the root of the problem may be organizational. There does not seem to be any institution in whose explicit interest it is to encourage the use of chemicals in Soviet agriculture. Chemical fertilizers may have lacked an advocate.

The Central Committee of the CPSU called for the establishment of an all-union agrochemical association, Soyuzsel'khozkhimiya, within the Ministry of Agriculture. Following existing divisions of the Ministry of Agriculture and Sel'khoztekhnika, the agrochemical association is to include scientific-production associations in union republics; production associations in autonomous republics, krays, oblasts and rayons; chemization points in enterprises; agrochemical labs, research institutes, and stations for produce protection. Soyuzsel'khozkhimiya will prepare proposals, draft plans, determine demand for mineral fertilizer, devise means of plant protection, lime the soil, provide feed supplements, order resources from Gosplan and Gossnab, deliver agrochemical goods, extract limestone and gypsum, oversee the improvement of land fertility, organize storage, conduct research, run pesticide campaigns, and train personnel.[115]

It is tempting to speculate that the need for Soyuzsel'khozkhimiya arises from the fundamental need for interest groups in the Soviet context in the first place. Interest groups provide the impetus to get things done. Conflicts arise as the list of things that need to get done increases in complexity, at which point the system that provides so well for the articulation of diverse interests (i.e., the adversary system) cries out for decision procedures to resolve conflicts. But this does not mean the adversary relations are harmful in themselves. One could almost say the more adversary relations, the better the system is able to articulate needs--provided conflicts can expect resolution. With the establishment of Soyuzsel'khozkhimiya, at any rate, the government institutionalizes an advocate of chemization.

CONFLICT RESOLUTION

Industrial conflict resolution takes many forms in the Soviet Union, some of which doubtless go unreported in the press. Nevertheless, it is possible to get an impression of both the variety and the apparent spontaneity of Soviet industrial conflict resolution through published case material. *Sovetskaya Rossiya,* for example, criticized Mintraktor for poor organization in servicing combines. A deputy minister for Mintraktor acknowledged publicly that the criticism

was justified and corrective action was taken. Dismantled combines delivered to the Altay similarly attracted *Sovetskaya Rossiya* attention, with the result that the Krasnoyarsk Production Association for Grain Combines held open plant meetings in conjunction with the Association's party-economic *aktiv*, finally dismissing the responsible deputy chiefs.[116]

Other industrial organizations may serve as the forum for conflict resolution. The former chairman of Sel'khoztekhnika (now Minister of Mintraktor), A. A. Yezhevskiy, chaired a meeting including officials from the Central Committee, the Council of Ministers, Gossnab and the People's Control Committee to discuss failures of various Mintraktor and Minzhivmash enterprises to provide timely deliveries of crankshafts, bearings, gears, pistons and piston rings, cylinder sleeves, plowshares, clutches, cutters, cutter-loaders, transporters for manure collection, and steam-generating boilers.[117] The chief of the Party Central Committee's Agricultural Machinebuilding Department, I. I. Sakhnyuk, chaired another conference including senior officials of the Central Committee, Council of Ministers, Gosplan, Gossnab, Gostekhnika, ministries, and branches to discuss technical faults that Sel'khoztekhnika had discovered but Mintraktor had never corrected.[118]

As mentioned in the Introduction, Hough and Skilling and Griffiths are excellent sources on Party intervention in economic affairs. Hough's analogy of local Party officials to prefects explains the inability of Communist Party officials fully to delegate the task of industrial coordination to the ministerial structure. Member of the Politburo G.V. Romanov, for example, participated in a Smolnyy Party *aktiv* meeting to organize the local Party, Soviet, trade union, and Komsomol (youth) organizations to improve Leningrad's fodder base.[119] In Belorussia, First Secretary Masherov discussed topics as varied as the shortage of machine workers (148 per 100 tractors), the poor retention rate of Belorussian-trained machine operators (36,600 of 165,000 trained--because of inadequate housing), the inappropriateness of various tractor productivity indexes, shortages of attachments for the new MTZ tractor, and even a proposal to mow grain and subsequently thresh the fallen windrows rather than to head and thresh standing grain in one step.[120] In Estonia, a reporter documents the efforts of a

newly appointed Sel'khoztekhnika rayon association leader--a "young and energetic communist"--to prosecute land reclamation plans with the assistance of a member of the local Party bureau. The Party cell in the association (100 communists), as in other enterprises in other sectors, trains cadres, manages socialist competition, and strengthens discipline, receiving orders from Central Committee plenums.[121] It almost seems that agriculture has come to rely on its administrative prefects to operate.

In 1965 the Central Committee of the Communist Party adopted a plenum resolution abandoning Khrushchev's willful and "subjective" approach to agricultural planning and substituting a more orderly, bureaucratic process. The plenum resolution criticized the "endless stereotyped instructions on agrotechnical subjects . . . without local conditions being taken into consideration," which collective farms and state farms received from above.[122] "This has hampered the initiative of managers and experts, of all toilers of the countryside, and has interfered with the normal conduct of affairs," it continued. Despite this reduction in interference, Party administrative functions require strengthening:

> Particular attention must be paid to the improvement and enhancement of the role of primary party organizations in the collective and state farms. Party raykoms must, in their daily work, rely on them and help them in the mastering of their organizational, political, and educational work among the masses.[123]

This is an instance of Zaleski's generalization that the Soviet Union is turning from central planning to central management: Party raykoms are to step up their administrative activities without interfering in local initiative and planning.

The clearest pattern that emerges in agricultural technology is the operation of an adversary system that often pits suppliers and clients against one another, but at least translates needs into institutional action and advocacy of such services as repair, grain elevator production, and chemization. The pattern of institutional advocacy of economic objectives in itself does not differentiate the Soviet adversary system from bureaucracy. The difference here is that the

advocacy and adversary system that serves quite well to articulate user interests in the agricultural sector seems to lack the fixed decision rules that resolve conflicts in bureaucracies, interest group coalitions (such as Congress and Parliament), and classical markets. One result is a confusion that would persist in the face of any reforms that did not explicitly address decisionmaking processes. Another result is a vehicle for client bargaining prowess that enables some to take advantage of the informal forums of arbitration.

Sel'khoztekhnika seems to function as a quality controller for the farms, a distributor or marketer for the producers, and a shield to protect the kolkhozes and sovkhozes from adversary disputes with the industrial sectors that service them. Unfortunately, nothing in Sel'khoztekhnika's constitution impels it to be a financially responsible arbiter, leaving financial conflicts of interest to create adversary relations between the Ministry of Finance and Mintraktor. Mintraktor seems to play the role of the man in white in its dealings with the Ministry of Trade (an unforgivable entity). The cases of both grain elevators and chemical fertilizer illustrate the Soviet system's need for institutional advocates of economic objectives, returning us to a plausible explanation for the creation of Sel'khoztekhnika: The farmers simply could not be expected to function competently as advocates in their own behalf in the Soviet adversary system.

It is difficult to evaluate Sel'khoztekhnika because it is hard to imagine what the sector would be like today without it. Sel'khoztekhnika may just multiply without benefit the adversary relations prevailing without governance in the agricultural sector. And Sel'khoztekhnika may not competently represent the interests of the farmers, as nearly all the desirable foreign tractors are going into sectors other than agriculture. But the farmers may not care: They do not pay for the tractors on most farms. The case of the uncaring client is not all that different from the case of the technologically incompetent client: In both, the nondefense economy misses the opportunity for the player with the most knowledge of a product--the client--to affect industrial outcomes.

IV. CHEMICAL EQUIPMENT CONSTRUCTION

The chemical/petrochemical equipment sector in the Soviet Union may be evolving into less of a producer and more of a service organization that assembles and supports foreign componentry and plant. Such an evolution is in line with what we would expect as the result of a high degree of risk-aversion among chemical equipment clients regarding equipment supply. Their risk-aversion follows from the lack of substitutes (especially in compressor turbine technology); the strong pressure from the center on energy sectors to perform; the high sensitivity of oil and gas ministries to equipment performance; and the Soviet mastery of applications engineering in the field. Unfortunately, the evidence is fragmentary and will not support firm conclusions, but it suggests reliance of the center on foreign technology as a function of the information provided by a client unable to tolerate shortfalls in equipment supply.

Extensive importing of chemical and petrochemical machinery has characterized this sector since Khrushchev's chemization (or chemicalization) drive in the early 1960s. This section explores how much industrial interests within the adversary system may have influenced Soviet import policy in this area. A brief examination of interactions between the Ministry of Chemical and Petrochemical Machinebuilding (Minkhimneftemash) and the central planning apparatus (Gosplan, the Council of Ministers, and the Party Central Committee departments), together with some examples of foreign trade agreements, introduces the research hypothesis that Minkhimneftemash industrial advocacy has partially determined trade outcomes in the chemical machinebuilding sector. (A case study by Philip Hanson supports the contention.) Minkhimneftemash advocacy of a hardpressed client (a variation consistent with the adversary model) may have produced overinvestment in foreign technology. The evidence does not permit the conclusion, however, that advocacy within the adversary system dominates low-level Soviet industrial decisionmaking in this sector to the exclusion of the interests of central planners. The picture of Soviet

economic decisionmaking that emerges is complex but nevertheless permits the exploitation of readily available information about Soviet industrial structure to improve predictions of Soviet foreign technology demand.

INDUSTRY STRUCTURE

A 1978 CIA paper on Soviet chemical equipment purchases from the West argues: "Large, unsatisfied requirements of industry, agriculture, and the consumer appear to underlie the bulk of Soviet chemical equipment orders."[124] These orders have included equipment for the production of multinutrient fertilizers, polyethylene, polyester fiber, and ammonia. The purpose of the large-scale importation of chemical equipment does not seem to be solely to develop domestic capability to produce machinery. The principal benefit, according to the report, seems to be rather the superior efficiency characteristics and the shorter lead-times of Western-equipped plants (four years rather than eight).[125] In short, the perception of unfulfilled domestic needs and the inadequacy of home-grown technology drive Soviet decisions to import technology. But it remains unclear how the decisionmaking system articulates those needs and inadequacies (particularly without a price structure) and why it responds to them with the short-term solution of technology infusion from abroad.

The chemical and petrochemical branches of Soviet industry employ nearly 5 percent of the total industrial labor force.[126] The industry has retained a high priority for technology imports since 1960.[127] Western machinery has accounted for nearly one-fourth of total machinery investment in the chemical sector since the late 1960s, higher than for any other documented industrial branch.[128] Western chemical technology, according to Hanson, feeds primarily into household-consumption end-uses.[129] Hanson agrees with the CIA conclusion that efforts to replicate foreign technology have been "rather unsuccessful."[130]

Industrial Advocacy

In 1973 the Central Committee criticized Minkhimneftemash on the following grounds, providing a detailed example of Party-industrial interaction. The structure of production management was too elaborate and its staff too large. The staff/employee and expenditure/employee ratios were too large compared with other machinebuilding ministries. The consolidation of enterprises and the conversion to a "shopless" factory structure was proceeding too slowly. Research and production associations suffered from poor organization; questions about centralization of auxiliary services, shops, and sections remained unresolved. The practices of the most efficient enterprises received insufficient attention. No action followed the "disclosures" of the People's Control Committee in 1969 of overexpenditures in the maintenance of the management apparatus--6.5 million rubles--including business trips, conferences, and frequent summons of officials to ministry headquarters. The criticism singled out a deputy minister, the labor chief, and the accounting chief for leniency in handling violations of state financial guidance.[131]

The client, whom we might by now expect to be even harder on the ministry, has voiced few objections to Minkhimneftemash performance. In a summary speech in 1975, V.S. Fedorov, the Minister of Petroleum Refining and the Petrochemical Industry (Minneftekhimprom), criticized lags in oil processing development, lags in the use of additives, the short supply of radial tires his ministry produces, the slowness of technical reequipping of the rubber industry, and the ministry's small share of quality mark products.[132] Nowhere a bad word for Minkhimneftemash! The Central Committee had previously praised Minneftekhimprom efforts to raise capital investment effectiveness, although it criticized construction progress.[133] It is possible that in this sector, client and supplier exploit the adversary system through cooperation.

Minkhimneftemash has a diverse charter. The ministry is responsible for supplying refineries to Minneftekhimprom, processing equipment to the pulp and paper industry, microbiological gear to Sel'khoztekhnika, and blast furnaces for oxygen plants. The Tenth

Five-Year Plan (1976-80) demanded 10-12 percent production gains. The ministry has produced steam generators capable of steel production and driving oil from wells. Central plans have required it to supply complex automated oil and gas processing systems, gas condensate, and new fertilizer plants to supplement those imported from the United States, Japan, and Italy The ministry is responsible for production of compressors, gas processors, pipeline, drilling rigs, bits, and oil and gas field tools. There is large-scale cooperation among Czechoslovakia, East Germany, and Minkhimneftemash, but the ministry remains overburdened. One commentator writes:

> But because the priorities set for the Chemical and Petrochemical Machinebuilding Ministry's customers' ministries are so high, Mashinoimport, Tekhmashimport and other Soviet Foreign Trade organizations will need to continue to place large equipment orders in Europe, America and Japan during the next five years.[134]

If Minpribor regards foreign technology import as competition, Minkhimneftemash looks at it as relief.

Organization

Examples of technology import are well documented in the Soviet press. With great regularity, the projects are of high visibility and involve chief-executive-officer signoff from the U.S. participant.[135] Perhaps the best-known agreement is the protocol signed by Armand Hammer and Gostekhnika in 1972. It provides for petroleum and gas exploration and processing, agricultural fertilizer sales, metal treating and plating, hotel design, and solid waste utilization. Sample and personnel exchanges, symposia, mutual consultations, joint R&D and program implementation, assistance in locating specialists and organizations working on specific problems in both countries, and license acquisition will implement the agreement. Hammer enjoys contacts with the Petroleum Industry, Minneftekhimprom, the Gas Industry, the Chemical Industry, Metal Machine-tooling, and agencies of the Moscow City Soviet in hotel design and waste utilization.[136] (Curiously, the Soviets have always insisted on signing with CEOs, not appreciating that their time is a firm's most expensive resource.)[137]

Hanson offers some interesting comments supporting the research hypothesis of this section. He refers to "the (apparently unique) adoption of a general contractor role in supply coordination and the installation of machinery by the Ministry of Chemical and Petrochemical Machine-Building."[138] It is Khrushchev's tactic of massive technology import that set the precedent "for domestic R&D to focus on complementary activities, and for domestic chemical engineering to dodge certain tricky new design and manufacturing responsibilities."[139] It also created lines of communication between the chemical ministry and Western contractors, and between the ministry and the Soviet foreign trade organization responsible for chemical equipment imports, Tekhmash. He continues:

> The power of branch ministries to influence their own plans and the momentum of established policies and practices in the Soviet economy may well have enabled the chemical and petrochemical ministries to perpetuate the large-scale buying-in of Western technology as an easy solution to their own problems, in the face of any intention of the central authorities to reduce this activity in the long run. [140]

During visits to the United States, the then Minister of the Chemical Industry, L.A. Kostandov,

> referred to possible purchases in terms suggesting that, within a certain (usually very large) hard-currency allocation, he can make his own decisions about choices of technology and supplier, and that he can, for example, override Soviet State Standards requirements and nonchemical industry influences on locational decisions in the interests of speedy acquisition of a capability.[141]

Even R&D outfits in the chemical industry are streamlined to complement foreign technology import.[142]

The Soviet supplier of chemical equipment (Minkhimneftemash) and the clients in the sector (Mingazprom, Minkhimprom, Minneftekhimprom) apparently cooperate in presenting Gosplan planners with the necessity of importing technology. Supplier-client cooperation does not figure greatly in the Soviet computer sector or agriculture, but the common

element in all three cases is that the adversary system operates to the disadvantage of the state. In this case, the ultimate client and the equipment supplier join up to create adversary relations with the central agency responsible for importing. The equipment supplier becomes in part a maintenance and assembly organization, shifting technological and design problems to the government, and eventually overseas.

The Tenth Five-Year Plan subjected all petrochemical enterprises to full financial accountability for five years, forcing them to pay for investments out of profits.[143] Moreover, associations within the sector compete from time to time. Thus the Association of the Petroleum Industry for the Tatar ASSR and the oil and gas association of Tyumen have competed under an agreement posting a shared total oil quota.[144] Such pressure, in the Soviet context, does not necessarily make the affected enterprises leaner; but it definitely encourages innovation in evading responsibility and difficult industrial tasks.

The hypothesis of a degree of cooperation in the chemical equipment sector should not suggest complete harmony. The Tomsk Petrochemical Plant was supposed to begin polypropylene production at 150 percent of the 1980 national level in the USSR. Khimstroi is the chief contractor and tried to blame the designers (standard practice) for schedule delays in construction. The responsible installation organization failed to meet all its early quotas for machine installation even though Gossnab had ensured that all materials were present. The governing construction ministry tried to delay the polypropylene commission. This effort appears to have failed. The Ministry of Power and Electrification planned only half the necessary power. The client, Minkhimprom (Ministry of the Chemical Industry), has not gotten all the equipment in place: Pollution control facilities were ready but sewage disposal facilities were not. The Tomsk Territorial Administration has interfered with the Ministry of Construction's housing plans for the new chemical workers' collective.[145] And yet this is unquestionably a priority project. Priority alone is therefore not sufficient to overcome inertia caused by the adversary conflicts that proliferate in complex projects.

Research and Development

The appearance in the Soviet chemical equipment sector of coordination in the research effort would indicate the absence of divergent industrial interest groups and would thus refute one of the principles of the adversary model. Similarly, systematic resolution of tradeoffs between research priorities would illustrate a functioning set of decision rules or procedures and thus falsify the second tenet of the adversary model. In both cases, the evidence that would rule out the model is lacking. There are, however, several comments that corroborate the adversary model, at least indirectly. A report from Sandia Labs, for example, states:

> The Russian drilling research appeared to consist of incremental improvements and solutions to specific problems encountered in the field. They appear to have abandoned nearly all research on new methods/systems.[146]

The dispersion of effort into ad hoc research projects reacting to specific technical difficulties suggests both a lack of consensus on research priorities (hence divergent interests) and a lack of procedures to decide major tradeoffs implicit in the constraints on any research agenda (hence no arbitral rules). The Sandia comment is consistent with Hanson's characterization of Minkhimneftemash as often operating in the role of a general contractor offering support services in the introduction of foreign technology.

Minkhimneftemash now organizes R&D institutes by type of machine-building and type of enterprise served rather than by production function, thus further suggesting its development as a contractor rather than producer. There is a thought-provoking similarity in trends toward expanded service sectors in both the United States and the Soviet Union. The ministry, furthermore, assigns its enterprises and institutes only main-indicator quotas, considerably freeing up decisionmaking on the plant floor. The ministerial collegium nevertheless conducts on-site review of work by research institutes and sessions to hear research directors and specialists. Minkhimneftemash has specifically earmarked 8 percent of its capital investment funds for lab construction,

experimental shops, research institute pilot facilities, and design bureaus. Every branch of the ministry enjoys its own experimental plant.[147]

Other ministries in the sector conduct their research with less applications engineering orientation: not as many experimental facilities and with a greater reliance on academic credentials and state funds. The All-Union Research Institute of the Ministry of the Petroleum Industry (Minnefteprom, not Minneftekhimprom) has a staff of 582 engineers, of which 19 have second level doctorates and 105 have candidate degrees. (The Soviet kandidat degree is, roughly speaking, between an American Masters and PhD degree.) This institute, however, can claim only 56 inventions over the past five years, or one for every 50 man-years. Of these, only 14 were practically applicable, and only one was "profitable." *Pravda* blames this inefficiency on the separation of plans for true inventions and so-called "new technology," which is merely cosmetic. The separation of plans supposedly impedes effective use of the "new technology" funds.[148] *Pravda* seems to be accusing Minnefteprom of goldplating. The Academy and the Party, at any rate, have pushed strongly for more experimental facilities.

The emphasis on applications engineering in the Ministry of the Gas Industry appears to be weaker than in its equipment supplier's organization. Of course, it is difficult to get a feeling for the ratio of basic research to development in Soviet industries beyond crude measures. The overall ratio of expenditures on industrial research to those on experimental design work is 1/4.8. Mintraktor has one of the lowest ratios, 1/5, indicating an emphasis on engineering. The ratio for the Ministry of the Gas Industry is 1/2.1.[149] What little product development and innovation that does get accomplished intertwines with academic research.[150] Pure science seems to offer a better career path in the Soviet Union than applications engineering. Industry must turn to the Institute of Chemical Physics of the USSR Academy of Sciences (the Soviet chemical engineer's academic nirvana) for process development. In 1976, 91 of their 116 projects centered on chemical and metallurgical process technologies, the remainder being distributed among transportation, agriculture, health service, and instrument building.[151] The broad picture, at any rate, is of an industrial

sector in which the equipment supplier emphasizes applications engineering for the client.

The Ministry of the Petrochemical Industry has established an all-union research and production corporation to improve its innovation record. The Neftekhim Corporation has a council of directors and a scientific and technical council composed of the industry's main institute directors, representatives of corporate management, and workers. The councils review construction projects, industrial development plans, and technical projects. Each institute of the corporation plans for plants and complexes in its vicinity. The VNIPINeft institute of Moscow and the Neftekhim Corporation's special design bureau succeeded in rapidly implementing an automated shop for polymerization of polypropylene at the Moscow Petroleum Refinery, for example. One commentator argues that the subordination of Neftekhim to an administration of the Ministry of Petroleum Refining conflicts with the multi-branch nature of its work and thus reduces its effectiveness.[152]

The Academy occasionally serves as the extra-ministerial organizer of such complex research efforts. The Western Center of the Ukrainian Academy, for example, organized a major research program in underground drilling machine design involving the L'vov Polytechnic, the I. Franks Institute of Petroleum and Gas, the Ukrainian Scientific Research Institute for Geological Prospecting, the L'vovneftegazrazvedka Complex, and the Drogobychi Drill Plant.[153] (This is not sufficient to remove the need for foreign imports. Sudoimport is purchasing $40 million of semisubmersible drilling machinery from Armco, supplied with blowout preventers, air compressors, air winches, and a fresh-water maker from Steard and Stevenson Oil Tools, Inc., and possibly subsea well-head equipment and motion compensators from Vetco in Ventura.)[154]

The case of vacuum equipment seems to prove that industrial branches can out-maneuver the center on technological issues. As of 1977 there was only custom production of such items as electrical discharge pumps in dispersed ministries. Vacuum equipment was an "unwanted child." Minkhimneftemash announced its refusal to undertake production of pumping equipment formally in a conference. The Ministry of Communications Equipment cut back on its vacuum measuring technology

R&D. Clearly, vacuum equipment has lacked an advocate in a decisionmaking system that seems to require some group sponsorship for anything to be accomplished. *Pravda* suggested that Gostekhnika should study the problem to determine whether the Academy of Sciences could organize a council on vacuum physics.[155] In other words, Gostekhnika and the Academy were to initiate and arbitrate. Once vacuum equipment gains an industrial advocate, a set of adversary relations between it and the branch-user ministries will presumably spring up, leaving the question of appropriate production levels open to arbitration.

CLIENT-SUPPLIER INTERACTION AND CONFLICT RESOLUTION

On the side of Minkhimneftemash outputs, one finds very subdued adversary relations between the producer and the client ministries. It may be in the interest of the Party to alter that situation. The historical pattern has been to attempt to reform the client by taking action on the client or the supplier. One commentator complains of the lack of information on the needs of the chemical, petrochemical, and oil refining industry. Do they need centrifugal machines operating at 1000-25,000 atmospheres? Or do they need piston machines operating at 4000-10,000 atmospheres? Is it necessary to upgrade a 7-8 atmosphere compressor to 10-12 atmospheres if developers are creating a "vibrationproof pneumatic tool?" The commentator contrasts this state of affairs with the clarity of oil and gas extraction demands.[156] The implication is that clearer technical requests have improved outcomes in the extraction sector.

Minkhimneftemash has experimented with wholesale trade to improve product distribution.[157] The experiment may not have worked, because factory outlets never spread into the chemical industry despite the widely publicized success of Minpribor instrument boutiques. Another reform-oriented effort was the shift of Minkhimneftemash enterprises to production and distribution of complete sets of equipment. The ministry also reorganized its research institutes and enterprises according to the product type of the client served.[158] Some organizations never win. Gostekhnika has since criticized the All-Union Scientific Research and Project Design Institute for Complete Technological Lines for lack of organization, staff, and engineering facilities, and on account of

late equipment deliveries that are often disassembled or otherwise nonfunctional.[159] But the Central Committee has clearly endorsed this general effort to improve technology diffusion in the chemical and petrochemical sector.[160] However, Minkhimneftemash accommodation of its petrochemical and chemical industry clients does not seem to have been the sector's big problem. Indeed, this branch seems unique because of its excessive concern with facilitating technology introduction (what Hanson calls general contractor services) and its lack of concern in pushing its own production lines. Given the availability of foreign technology, this arrangement seems to suit client and supplier quite well.

Robert Campbell's work on the efficiency of gas transport provides a final case on client-supplier interactions.[161] Compressor power per volume of line, he notes, is now greater in the Soviet Union than in the United States. Throughput remains lower, however. He dismisses pressure as an explanation and suggests instead that pipe repairs, fouled lines due to inadequate gas preparation, compressor problems, inadequate storage or buffering at the delivery end, and inefficiency in compression per unit of capacity account for gas transport shortfalls.[162] Imported pipe, as a consequence, has accounted for as much as 58 percent (1961-75) of the new pipe investment.[163] It is not that the Soviets cannot produce sufficiently thick pipe, it is rather the low yield strength, wall thickness, and workmanship of Soviet pipe that prevents their use on lines under more than 55 atmospheres of pressure.[164]

The Soviets are also after gas-turbine-powered compressors. By 1975 they had deployed 10 MW compressors to cover a quarter of their total capacity but were still developing 16 MW and 25 MW models.[165] The attempt to develop aircraft engines for compressor use failed to realize capacity improvements.[166] In addition to the failure to meet production targets for compressors, the compressors produced experience an average breakdown cycle of 1970 hours, compared with 25,000-40,000 hours for American units.[167] Campbell notes that the Soviets use 158 GE compressors on the Orenburg line.[168] He estimates that the gain from importing is higher quality and better life-cycle parameters.[169] There is also a gain from speeding up gas production: "The gain from

accelerating availability in one year alone is enough to pay for the whole compressor import program." He arrives at this startling conclusion assuming a one year lag in domestic deliveries compared with foreign deliveries--an assumption we have seen to be conservative.[170]

Campbell finds that planning articles tend not to view Soviet R&D and foreign technology inputs as competing input resources capable of intersubstitution.[171] Hanson's point that the chemical equipment sector has evolved in part as a comfortable support service for foreign plant is consistent with this. Nevertheless, the Nevskii Plant, the Leningrad Metal Plant, and the Ural Turbomotor Plant are all working on compressors. The failure in domestic innovation seems to occur not at the research but the production stage, at which point imports become an attractive stopgap.[172]

The adversary system is not operating in the Soviet compressor campaign in an obvious manner--all good rules have exceptions--but its vestiges are still there. The importance of client competence--at least in specifying mission or usage requirements--lingers on. But why would this be, if the economy were truly centrally planned rather than just centrally administered? Soviet compressor problems, furthermore, would not vanish even under an ideal incentive structure. There is no evidence that participants in the gas campaign lack motivation. Given the Kremlin's political perspective, emphasizing the importance of invulnerability to external pressure, there appears to have been overinvestment in foreign compressors, as the Soviets had not developed domestic capability to exceed 10 MW in a unit that proved necessary to prosecute the program in the face of a U.S. embargo. The lack of decision rules has permitted a client and supplier to collude to force Gosplan to import extensively. An important adversary relation develops between the gas/oil sector and the government.

The petrochemical and chemical machinery sector is not a case of client incapability. In 1977, new capacity in Western Siberia, Udmurt ASSR, Komi ASSR, Perm Oblast and the Georgian SSR caused overfulfillment of all extraction plans.[173] Reading industrial articles on chemical equipment, one gets the impression not of baffled consumers and rigid, dull, bureaucratic producers but rather of clever if lazy industrialists integrating themselves into a world market that, for the price of state

capital or a few countertrade agreements, will solve their problems for them. This is markedly different from the overall Soviet pattern, criticized in a recent article on license purchasing. In 1979 the Federal Republic of Germany bought $1.3 billion of licenses, Japan bought $1.2 billion, the United States bought $700 million, and the Soviet Union bought only $64 million.[174] If it were not for the premium the Soviets place (perhaps with good reason) on self-reliance, one could easily argue the Soviets pitifully underinvest in foreign technology. The chemical and petrochemical machinebuilders, on this view, would represent the wave of the future. Any American manager who has watched the explosion of marketing, acquisition, and other service functions at the expense of production in the United States would find the trend familiar.

To sum up: The lack of hostility between Minkhimneftemash and its clients does not rule out the adversary model. Coordination in R&D would weaken the principle of divergent industrial interest groups, but we do not find this. The appearance of systematic resolution of research priority tradeoffs would refute the principle that low-level Soviet industry, despite the presence of divergent interests, lacks standard arbitral or decision procedures to resolve conflicts. But again, we do not find any systematic translation of planning priorities into implementation tradeoffs, especially in R&D. What we do find is an overburdened sector (both supplier and clients) that has evolved in the direction of a service sector. Thus Minkhimneftemash strikes Hanson as a sort of general contractor providing auxiliary services to the client in support of foreign mainline technology. The evidence even points in the direction of interministerial complicity or advocacy to secure a stream of back-up proven technology from abroad when technical problems threaten to overwhelm. Industrial advocacy both of other ministries and of certain technologies (e.g., vacuum equipment) fits neatly into the general adversary framework.

There remains a question about the sense in which the arrangements in this sector cause overinvestment or underinvestment in foreign technology. Were it not for the importance to the Soviets of self-reliance, we could forcefully argue that the Soviets underinvest generally in foreign technology. Accepting the weight of the value of

self-reliance demonstrated in general Soviet trade practice, however, we see that chemical machinery is out of line. Indeed, the potential effectiveness of a pipeline compressor embargo illustrates the Soviet chemical machinebuilding sector's unusual reliance on the West. We may at least characterize Soviet demand for foreign chemical technology as fairly inelastic.

This sector has offered another variation on client characteristics. Soviet chemical and petrochemical industrialists, even if lazy, do not appear to be incompetent consumers of equipment. They tend to maintain foreign machinery and understand their options well enough to prefer it. The example of clever, technologically competent, and politically astute clients complements the computer sector's incompetence and agriculture's apathy.

V. CONCLUSION

This study has outlined a decisionmaking model that attempts to explain the importance of client characteristics to industrial outcomes even in the absence of a price system or a market structure. The first principle of the model is that low-level decisionmaking in Soviet nondefense industry involves numerous conflicting interests, typically clients and suppliers who adopt adversary or advocacy roles. The second principle is that this system fails to provide routine arbitration or decision procedures to resolve industrial conflicts once it has encouraged the articulation of often incompatible interests. The effect of these two principles is the constant need for ad hoc industrial adjudication, much of which is probably supplied by Party officials at various levels who are frequently unversed in the technologies involved.

Adversary roles proliferate particularly in agricultural machinebuilding: We have seen conflicts between Mintraktor and Gosplan, Mintraktor and the Ministry of Finance, Mintraktor and the Ministry of Trade, Mintraktor and other production ministries, and the Ministry of Procurement and the grain elevator contractors. The existence of this adversary system helps explain why Sel'khoztekhnika has not improved outcomes in the tractor sector even though the research hypotheses would lead us to expect an upturn with the institutionalization of a buyer advocate. Sel'khoztekhnika has merely multiplied the number of unadjudicated adversary relations in the sector. The apparent need for institutional advocates to prosecute technologies such as chemical fertilizer production (Sel'khozkhimiya) and vacuum equipment further corroborates the adversary model.

On the basis of the cases presented, we might expect a broad connection between the decision to import technology in the Soviet Union and the nature of the recipient ministry. Such a result would not be out of place in a market with profit-maximizing behavior. But on closer examination, there is an inconsistency with the market model. It is not client competence but client utility that affects economic decisionmaking in a market. It is the client's willingness to pay for

computers and support services that affects IBM's activities, not the client's proficiency with the technology. The situation for Minpribor is reversed. Indeed, client incompetence seems to drive outcomes in the Soviet computer sector. Of course, other factors contribute to the dismal record of Soviet effort at computer technology diffusion, such as the pressure on an enterprise to remain independent of suppliers and clients, and the vulnerability of Soviet computer usage to misinformation from uncooperative comrades on the production line.

The general theme carries over into other Soviet sectors. The irresponsibility of farm equipment buyers characterizes tractor acquisition to the extent that the sector seems insensitive to easily remediable failings in Soviet tractor life-cycles. And the clever maneuvering of chemical and petrochemical equipment buyers, together with their apparent close cooperation with Soviet domestic supply organizations, has created uncharacteristically high reliance on foreign goods. The examples of incompetent, irresponsible, and risk-averse clients broaden the base of support for the research hypotheses. But it is principally the interaction between Minpribor and its clients that should incline us toward the present generalizations about the effect of clients on Soviet nondefense industrial decisionmaking.

The approach taken here toward assessing the effect of incentives on Soviet economic decisionmaking is not different from the approach of Joseph Berliner: Incentives are crucial, but only in the context of the entire decision system. This implies that any emphasis on the isolated effect of incentive structure on industrial outcomes is likely to result in a biased analysis of low-level nondefense industrial decisionmaking in the Soviet Union. (Omission of a significant explanatory interaction term crossing the incentive structure and the decision system biases the estimated effect of incentive structure on economic outcomes, to make a metaphor of factor-response models.)

Soviet computer development is a casualty of an incentive system that rewards unthinking acquisition of equipment as opposed to its useful employment. But one must ask whose interests the incentive system serves, and what process instituted that system. It is plausible that Minpribor has bargained successfully for a set of rules that encourage computer diffusion to the benefit of the producer but not of

the unready customer. The incentives in agriculture create apathy; but this apathy is further embedded in a decisionmaking system that requires institutional advocacy to accomplish economic objectives and in which the apathy first becomes vicious. Petrochemical and chemical equipment producers and buyers appear well motivated but exploit the complexities of the adversary system to rely in considerable part on foreign technology; to that extent they transform their position from low-margin producers to high-margin contractors and providers of support services. Incentive reform in the Soviet Union will alter nothing if it does not overhaul the decisionmaking system as well.

Chemical-petrochemical machinebuilding is distinctive among Soviet machinery branches in the extent of its reliance on foreign imports. The American sanctions of 1981-82 put in relief the political riskiness of such a policy. Of course, in view of the qualitative inferiority relative to foreign counterparts of much Soviet machinery and the evidence of lengthy lead times for new equipment production capacity, it is reasonable to suppose that the USSR is generally underinvesting in foreign technolgy. Again, Sel'khoztekhnika overinvests in new equipment with respect to consequent economic benefit, as seen from the point of view of the Ministry of Finance (which foots the bill). And computer buyers overinvest when they store expensive equipment in the basement of a youth hostel next to the showers. The decisionmaking system that seems to underlie the case material examined here has no predisposition against underinvestment or overinvestment, because it is insensitive to any practicable measure of usefulness of the technologies clients are trying to apply. It is possible any given Soviet sector is overinvesting in foreign technology, but we cannot assume without further information that U.S. foreign trade sanctions will impose economic costs on the targeted Soviet ministries.

Assuming that we understand top-level Soviet economic policy, the price and cost structure of the industries in question, and an account of relevant hard currency countertrade practice, the considerations of this Note would permit further refinement of predictions of Soviet economic decisionmaking that exploits information on the nature of the client ministry. These considerations should also have a direct application in the projection of Soviet demand for foreign technology in

nondefense sectors. That demand, once again, is partly the product of information arising from bilateral negotiations among various supplier and buyer organizations, and not just the result of the activities of a central planning agency such as Gosplan or of a Central Committee department. But the negotiations go on in an environment of uncertainty, lacking fixed arbitral procedures. The upshot is that feedback reaches Soviet suppliers by very strange channels. Feedback there is; but we must understand the structure of clients as well as suppliers to comprehend it and to exploit it in predicting Soviet economic behavior.

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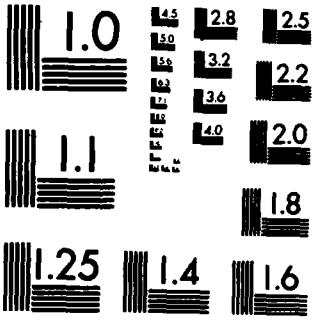
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NOTES

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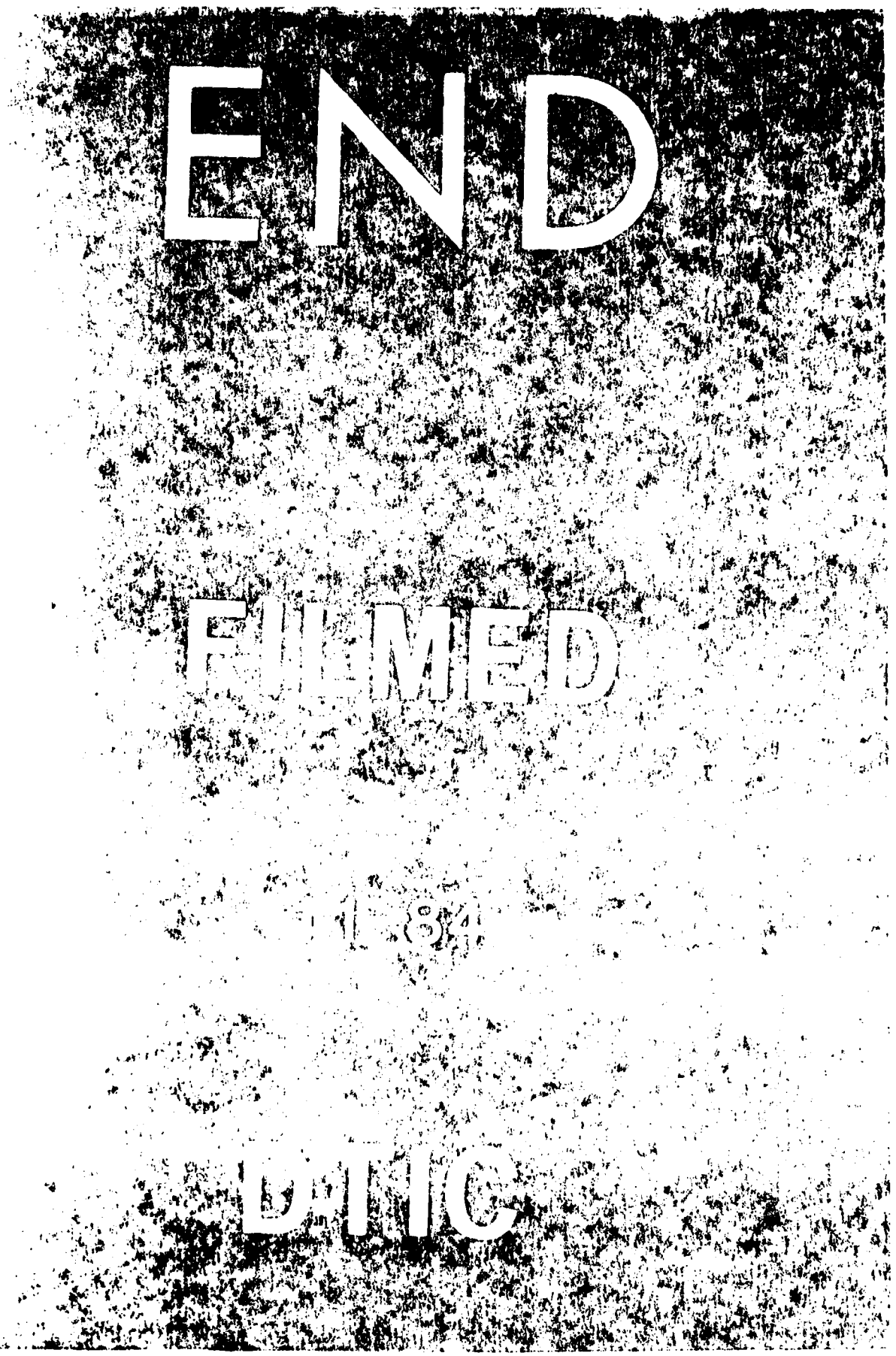
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